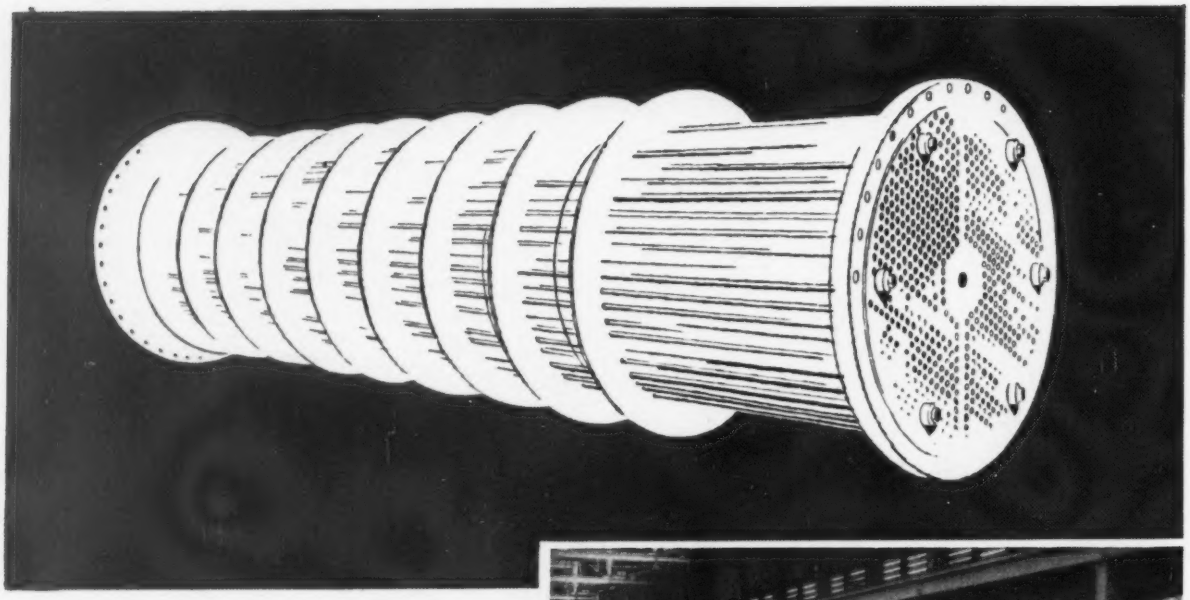
5 JUNE 1959

METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS

VOL 94 No 23 ONE SHILLING

SERCK TUBES AND G.W.B.



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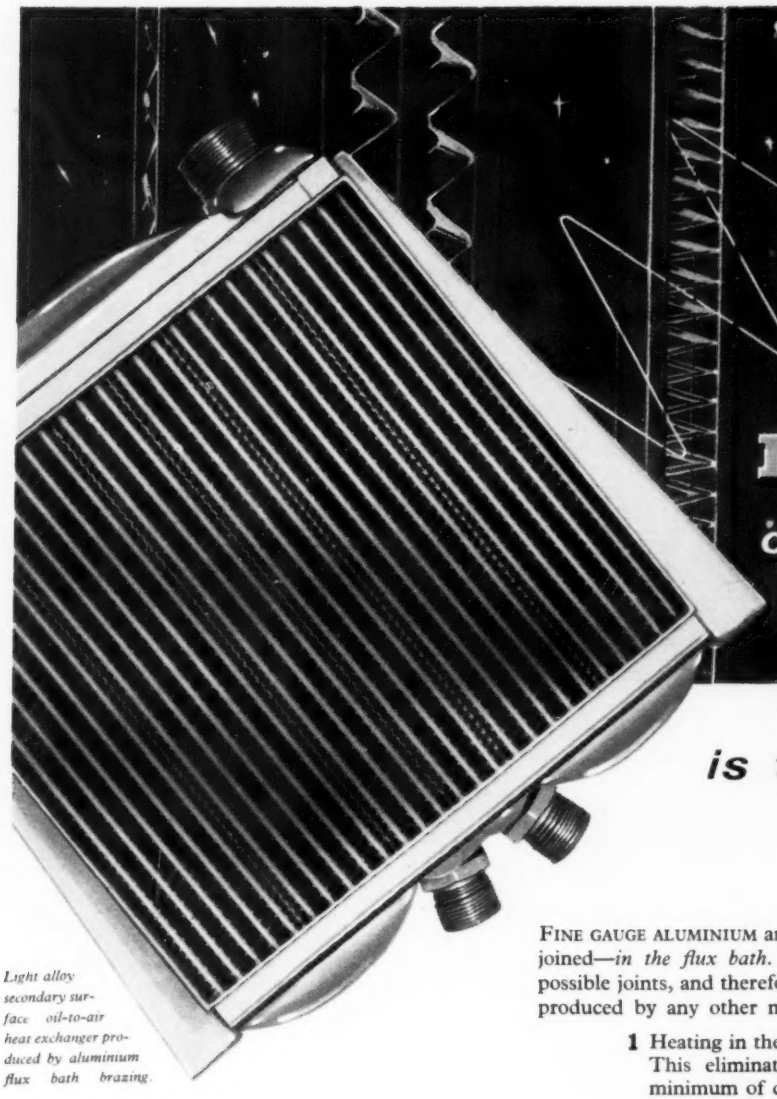

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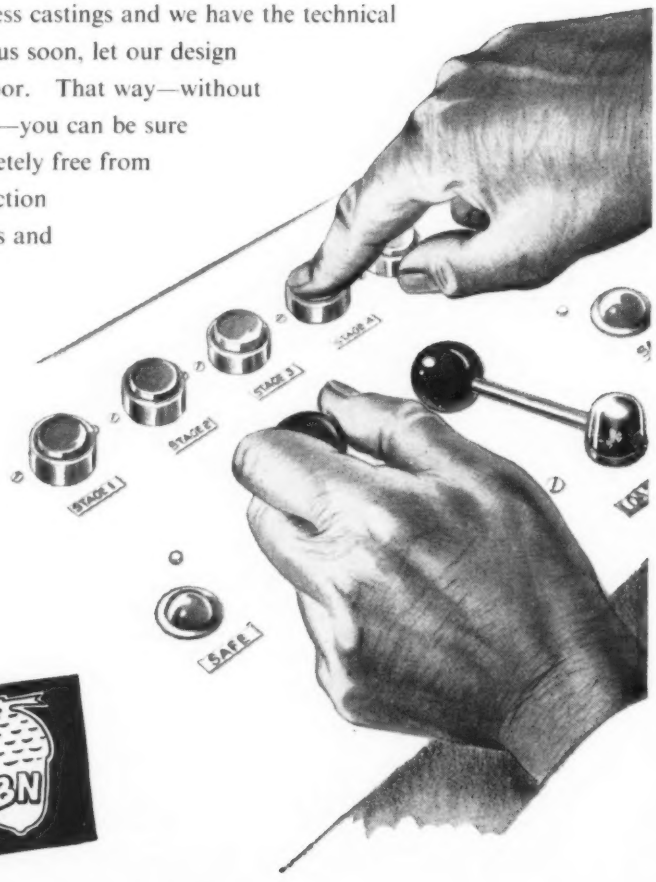

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METAL INDUSTRY

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Improving Materials

IMPROVEMENT in the properties of existing alloys, the development of new materials and a better understanding of the fundamental factors responsible for the behaviour of metals are the objectives to which the main research effort of the Metallurgy Department of the National Physical Laboratory is directed. Although, naturally, a considerable part of the work is concerned with ferrous materials, a survey of the recently published "Report of the National Physical Laboratory 1958" shows that non-ferrous metals are by no means neglected.

Thus, in connection with materials for special duty at high temperatures, work is in hand on the relative creep strengths of modern alloys available for the compressors and turbines of aircraft engines. For the former application, alloys with a titanium base are under investigation; for the latter, proprietary materials with a nickel-chromium base. The effect of hydrogen in amounts of the order encountered in manufacturing operations is also being studied on a commercially-produced titanium alloy. Further, in the new vacuum creep units developed in the Laboratory, creep tests are being conducted on experimentally-produced molybdenum alloys containing additions of alloying metals or of metallic oxides. These additions have resulted in improvement in creep strength in certain cases. An investigation is also being made of the notched fatigue strength of commercial aluminium alloys under conditions comparable with those often occurring in aircraft structures, that is, with a small alternating load superimposed on a high static load. The highest fatigue strength under these conditions has been obtained in an alloy heat-treated to give a low proof stress, even although this is also accompanied by a reduced tensile strength.

Large quantities of niobium now being potentially available, the question of finding applications for the metal is becoming of increasing importance. Since one important possibility is that niobium might replace such metals as titanium and vanadium in alloys for high temperature service in the hope that their creep resistance may be further improved, the investigation into the effect of niobium additions to nickel-, chromium-, cobalt- or iron-based alloys has been continued. Preliminary results indicated that the solid solubility of niobium is greatest in nickel-based alloys, and that it markedly increases their resistance tc recrystallization after cold work. Attention has, therefore, been concentrated on these alloys, and a number of materials have been prepared in bar form and subjected to controlled amounts of cold-work with the object of determining their creep resistance in these conditions. Investigation of the electronic structure of niobium alloys and of the niobium-hydrogen system has also been continued. New work undertaken includes an investigation into the causes of embrittlement of titanium-aluminium alloys.

In the Metal Physics section, fundamental factors in the creep of metals have been studied by means of the electron microscope. Measurements are also being made of segregation and surface energy in copper-antimony alloys. The results are expected to be useful in connection with the problem of fracture, since the energy of the surfaces produced when fracture occurs is believed to be an important factor. The particular alloys selected were chosen because antimony is known to cause serious embrittlement of copper, and would thus be expected to reduce the surface energy markedly. Subsequent activation of the specimen enables the surface composition to be determined by a radioactive method developed for earlier work on iron-phosphorus. It has already been shown that antimony substantially reduces the surface tension, but the measurements of the excess of antimony at the surface by the radioactive method are not yet complete.

Out of the MELTING POT

Invisible Magnets

IT is now fairly generally known that if pure iron, which in its normal state exhibits practically no permanent magnetization, is obtained by suitable methods in the form of particles the size of which approximates that of magnetic domains, such individual particles constitute minute permanent magnets. If an assembly of such particles is properly oriented and then fixed in that position by the introduction of a metallic or organic binder matrix, the resulting product will have excellent permanent magnetic properties. It may be deduced from theoretical considerations that for optimum results such a body should contain parallel elongated and suitably equispaced iron particles, each about 0·02μ cross-sectional diameter. Although the results obtained by compacting such submicroscopic particles have been of considerable scientific and commercial interest, the desired degree of uniformity of particle characteristics could not be achieved in this way. In an endeavour to avoid some drawbacks of the previous methods, F. B. Levi, of the Rola Co. (Australia) Pty., Ltd., has developed a method involving the drawing of compacts containing parallel iron wires embedded in a copper alloy matrix until the iron wires become invisible filaments and the compacts acquire a high intrinsic coercive force. Values of 300-700 Oersted have been obtained so far. Patent applications have been filed in respect of these methods and materials. Provided the materials within the compacts and the reducing methods are suitably selected, it is possible to preserve a fair uniformity of the iron cross-sections and spacings until the filaments are a few microns in diameter. After reduction below the limit of optical microscopic resolution, magnetic measurements suggest that the filaments preserve their alignment and that some of them satisfy the theoretical requirements even when their estimated diameter is smaller than 0·1μ. The best results so far have been obtained only in very fine brittle wires drawn under conditions of extreme cold work and then annealed. More ductile compacts, allowing further reductions, have generally produced lower coercive forces at any given estimated equivalent filament diameter.

Wrong Emphasis

FOR a variety of reasons little can be done about the publication of the results of original research; unnecessary publication, that is. To begin with, the results of any original research are regarded as being valuable, and publication, which makes them widely available, is, therefore, likewise considered to be of value. After all, any original research, once it has been satisfactorily completed, is a step forward, and must be suitably recorded. The efforts that have been made in the past, and which continue to be made, to ensure publication of such records of the progress of original research are well known. Apart from providing a permanent record, such publication is intended to help others working in the same field and to ensure, so far as possible, that the same ground is not covered more than once unnecessarily. Those are some of the more admirable reasons. There are others. But even these admirable reasons cannot justify the publication of some of the work one comes across. Nobody can quarrel with progress being made and recorded, but progress must not only be made, but must also be seen to be made. It must start from a clearly defined point and reach another clearly defined point, the first of these points having been reached by some previous bit of progress. In actual fact, the progress made by much of the published research work seems to start from wherever those who did the work happened to be at the time. The reason for it in many cases seems to have been no more than a pointless: "Where do we go from here?" This question should certainly be asked, and some attempt made to answer it; but at the end, not the start, of an investigation. Unfortunately, this is hardly ever done, the results being usually left to speak for themselves, which they hardly ever do. Saying nothing or very little about where and why it started, accounts of research work usually have far too much to say about how it arrived at something the use of which, if only as a starting point for further research work, is left unspecified. Would it not be possible to take for granted that the work has been done, the evidence has been obtained, and the results have not been "cooked," and instead to be told a little more about the meaning of the results in relation to their context. At present too much of the research *work* described is, in fact, just work. More evidence of research *thought* would be welcome and, incidentally, would take up much less space.

Good Shooting

ALTHOUGH they have the use of explosives in common, it is obviously a very far cry from pheasant shooting to the use of explosives in the working of metals. Strange though it may seem, one or two things about shooting pheasants are not entirely without relevance to the application of explosives to metals. Take, for example, the law, convention, practice—call it what you will—of not shooting at sitting birds. Until they were led astray by the impossible new metals and alloys, and by the demands of traditionless newcomer metal-using industrial developments (if, indeed, industrial is the right word to apply to jets and rockets), metallurgists would no more have thought of using explosives to form metals than Colonel Blimp himself would think of stalking and shooting a sitting pheasant. However, metal fabricators are now, in increasing numbers, blithely banging away at their sitting targets and actually boasting about the results they obtain. Turning away from this display of brute force and ignorance, one may observe at least one example confirming that sporting instincts, and that indefinable something that in pheasant-shooting circles marks the gentleman and in industrial circles the inventor, are not entirely extinct among the protagonists of the use of high explosives in the metal manufacturing industry. The example is provided by a method of obtaining a test piece from a rapidly *moving* strip. The need for this is encountered in modern strip mills running at high speeds and producing vast quantities of strip from which test pieces have to be taken periodically. By arranging a suitably shaped explosive charge and a suitably apertured blanking die on opposite sides of, and in close proximity to, the moving strip, the required test piece can be literally shot out of the rapidly moving strip as and when required. Surely there must be some sportsmen other than strip mill operators who would find shooting at other moving targets a worthwhile undertaking.

Skimmer

Anti-Friction Coatings of Sprayed Pseudo-Alloys

By PROF. L. V. KRASNICHENKO

INCREASED demand for bearing alloys, their high cost and occasional short supply, have led to research work into materials that could replace bearing bronzes and other bearing alloys in sliding bearings. The electric metal spraying laboratories of the Mechanical and Agricultural Construction Institute at Rostov on Don have developed new anti-friction materials, referred to as pseudo-alloys, by making use of the electric metal spraying process.

The essential feature of this development is that the wires of the different metals required are fed in at speeds corresponding to the composition of the pseudo-alloy it is desired to obtain. The ends of the wires, which come into contact with one another, melt as a result of the heat generated by the electrical short-circuit, and the molten metal is carried away by a jet of compressed air which pulverizes the metal and deposits it on the surface to be coated. A layer of the required thickness is deposited in this way.

By changing the speeds at which the wires are fed into the spray gun, as well as the composition of the wires, it is possible to obtain pseudo-alloys of different compositions. Compositions studied in the Institute's laboratories include over 50 pseudo-alloys belonging to the copper-lead, copper-aluminium, steel-copper, steel-lead-aluminium, steel-brass, and other combinations.

In view of the high temperature reached in the electric spraying process and the high partial pressure of oxygen in the stream of compressed air, the particles of molten metal become coated with a film of oxide as they travel from the spray gun to the surface to be coated, the thickness of the film depending on the operating conditions, e.g. the distance between the gun and the surface being coated, and the nature of the metal being sprayed.

TABLE I—VARIATION IN WIRE AND DEPOSIT COMPOSITIONS

Material	Composition (per cent)					
	C	Mn	S	P	Oxides	Nitrides
Wire	0·14	0·50	0·020	0·032	Very little	Very little
Deposit	0·08	0·30	0·014	0·026	10·5	1·5

The compositions of the deposits differ appreciably from those of the materials sprayed. For example, Table I gives the composition of a steel wire used for spraying and of the deposit obtained.

From Table I it can be seen that spraying of the metal is accompanied by the burning away of carbon and other constituents of the steel, and by the formation of large amounts of oxides and nitrides (10·5 and 1·5 per cent, respectively, by weight of the deposit).

Copper, lead and aluminium oxidize more slowly but in their case, also, the deposited pseudo-alloys contain much more oxide than the starting materials.

The presence of these large quantities of oxides in the deposits (simple or alloy) is a characteristic feature which determines to a marked extent their structure and properties.

The microstructure of two pseudo-alloys (PMS30—70 per cent copper-30 per cent lead, and PStM15—85 per cent steel-15 per cent copper) is shown in Figs. 1 and 2.

These pseudo-alloys appear to be of special interest, because their exceptional properties enable them to be compared with bearing metals and bronze of the best grades.

The structure of these and other sprayed pseudo-alloy deposits is characterized by the wavy shape of the deposited metal particles, which are separated one from the other by oxides and pores. The wavy shape of the particles is due to the fact that almost all of them are in a molten state at the time they impinge on the surface being coated. On impact, the oxide films surrounding the particles are ruptured and the molten metal of the drops spreads out over the surface. In spite of the short time during which these particles are formed, a film of oxide still has time to form on their surface.[1]

The oxides present in these pseudo-alloys take three forms: relatively large bulky inclusions (these are derived from the oxide films which are destroyed during the melting of the metal and the movement of the particles); thin films, which surround the wavy particles and which are formed during the cooling of the metal; and, finally, microscopic particles dispersed through the mass of the metal.

In steel-base pseudo-alloys, the oxides are represented mainly by ferrous oxide. The presence of this compound, which normally would not have been expected in metal cooled to room temperature, is due to the rapid cooling of the sprayed particles as a result of which the ferrous oxide is unable to change to ferric oxide but stays in the metastable form. In copper-base pseudo-alloys, one finds cuprous oxide, which is present in the structural forms described above.

In the photomicrographs reproduced, the metal base of the first pseudo-alloy consists of wavy particles of the sprayed copper and lead. In the second photomicrograph, the matrix consists of steel with inclusions of copper.

The darkest portions of the photomicrographs represent pores. The size of these is very variable, ranging from 0·1-0·3 mm. in diameter down to microscopic dimensions. The small and smallest pores extend through the particles of the metal, giving them a sponge-like structure.

The porosity of the pseudo-alloys attains 8-15 per cent by volume. The pores act as oil reservoirs and thereby contribute to the maintenance of the steady lubrication of bearing surfaces, even under unfavourable service conditions of high specific pressures and high speeds of sliding.

As regards the properties of the pseudo-alloys, they have little in common with those of the metals used

Fig. 1—Microstructure of the pseudo-alloy PMS30 (×200)

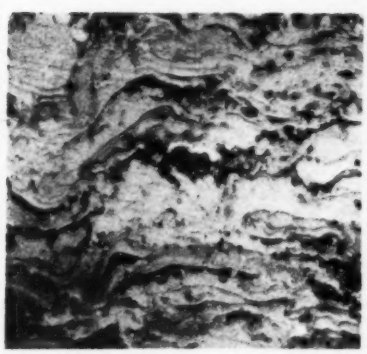


Fig. 2—Microstructure of the pseudo-alloy PStM15 (×200)

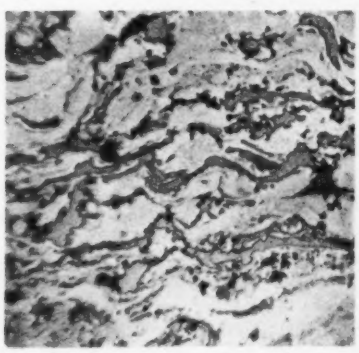


TABLE II—PROPERTIES OF WIRES AND DEPOSITS COMPARED

Properties	Materials							
	Steel 0·14 per cent C	PSt	Copper	PM	Lead		PStM15	PMS30
					Cast	Sprayed		
Porosity (per cent)	minute	12–15	minute	12–17	minute	3–6	10–15	10–15
Density (gm/cc)	7·8	6·1	8·9	7·1	11·3	12	6·5–7·0	7·5–8·0
Modulus of elasticity (kg/mm²)	20,000	7,000	10,000	5,000	1,600	7,000–1,000	6,000–6,500	3,000–5,000
UTS (kg/mm²)	46	10–13	22	3·6–7·0	2	1	10–12	3·5–5·0
Brinell Hardness	124	140–220	45	40–60	3	25–35	120–150	35–45
Microhardness	300–600	60–70	69–95	—	—	—	—	—
Elongation (per cent)	24	minute	30	up to 1·0	50–60	2–5	up to 1·0	up to 3·0

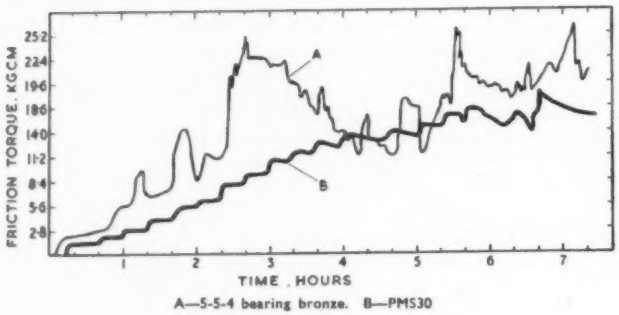
for their production. In Table II are given the physical and mechanical properties of the wires used for spraying and those of the pseudo-alloys PSt, PM, PStM15 and PMS30.

From the results given in Table II it can be seen that the modulus of elasticity of the simple and composite pseudo-alloys is two to three times less than that of the original metals. The ductility of the pseudo-alloys is practically zero. The hardness and, in particular, the microhardness of the pseudo-alloys is considerably higher than that of the metals used.

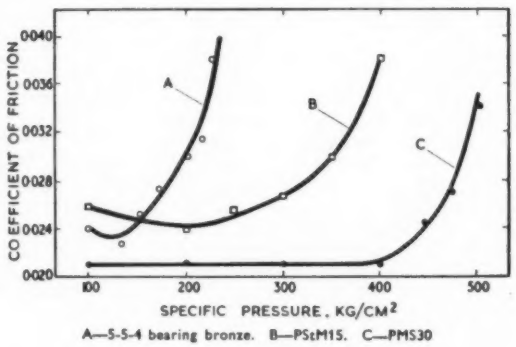
The poor strength and ductility of the pseudo-alloys is due to the presence in their structure of large quantities of oxides, nitrides and pores, as well as to the limited adhesion between the particles. On the other hand, whereas the microhardness of the steel wire used is 95 kg/mm² (ferrite grains), that of the particles of the PSt pseudo-alloy formed by spraying this wire is three to four times greater. This marked increase in hardness must be attributed to the saturation of the pseudo-alloy with oxides and nitrides as well as, in part, to the pronounced metastable state of the pseudo-alloy. Quenching effects and internal stresses play only a minor part.

The properties of the composite pseudo-alloys PStM15 and PMS30 are determined by the same factors and are additive.

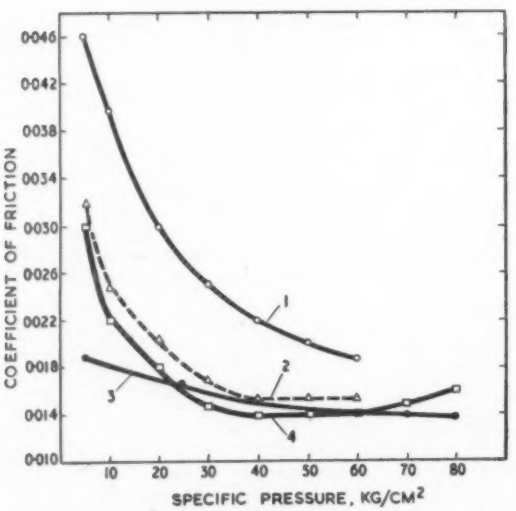
In addition to determining the chief properties of the pseudo-alloys, the latter were subjected to friction tests. These tests showed that the pseudo-alloys PStM15 and PMS30 possess a combination of the highest physical, mechanical and anti-friction properties. The friction tests were carried out on improved machines built in the laboratories of the Mechanical and Agricultural Construction Institute and incorporating an arrangement for the automatic and continuous recording of the friction during a test.[2]



A—5-5-4 bearing bronze. B—PMS30



A—5-5-4 bearing bronze. B—PStM15. C—PMS30



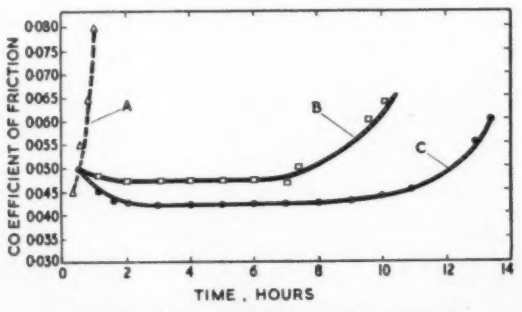
1—5-5-4 bearing bronze. 2—Tin-base bearing metal (83 per cent tin). 3—PMS30. 4—PStM15

Above left: Fig. 3—Friction torque curves for bearing bronze and pseudo-alloy PMS30

Left: Fig. 4—Coefficient of friction in relation to the specific load

Above: Fig .5—Coefficient of friction at high bearing pressures

Below: Fig. 6—Coefficient of friction during operation without a supply of lubricant



A—Tin-base bearing metal (83 per cent tin). B—PStM15. C—PMS30

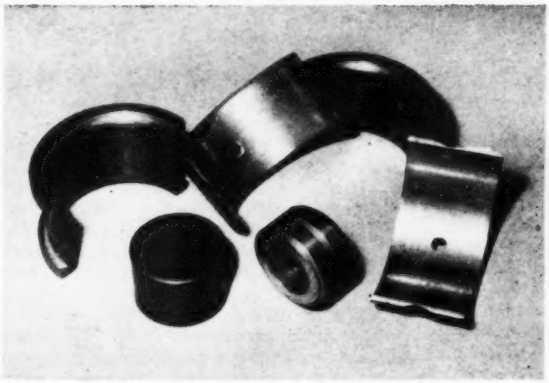


Fig. 7—Bushings and bearing shells with bearing surfaces coated with pseudo-alloys

The ring-shaped test specimens with coatings of different bearing metals and of the pseudo-alloys were run against hardened steel surfaces having a hardness at the bearing surface of about 50 Rockwell C. Adequate lubrication was provided, and the sliding speed was 1·33 m/sec.

The load on the specimens was increased continuously from 4 kg. to 80 kg. Before the actual test, the specimens were run-in at loads of up to 25 kg/cm^2.

The friction torques for the steel-bronze (5 per cent tin, 5 per cent zinc, 4 per cent lead) combination and for the steel-pseudo-alloy PMS30 combination are shown in Fig. 3. The curves for the other combinations tested have not been reproduced since they present no other new features.

During the whole of the test, the curve of the steel-bronze combination remained very irregular, developing numerous sharp peaks. The combination behaved abnormally, with a considerable rise in temperature. The peaks of the curve were occasioned by seizures. The sharp rise of the curve between the second and fourth hours of the test, when the friction torque attained 25·2 kg/cm., was due to seizure accompanied by plastic deformation of considerable volumes of the metal and some tearing away of particles of the bronze. This was followed by some running-in of the bronze surface, the friction torque falling off at the same time from 25·2 to 11·2 kg/cm. over a period of 1 hr.

Afterwards the curve again developed peaks, the friction increasing rapidly during quite short spaces of time. The behaviour of this combination was studied over a total time of 7 hr. 20 min.

The curve obtained with the pseudo-alloys PMS30 differs from the preceding. Here, the increase in friction with increasing load takes place gradually, sudden changes are almost completely absent and cannot be recorded by the machine. During almost the whole of the test, the curve for the second combination lies below that of the first.

At the end of the test, the temperature of the steel-pseudo-alloy combination had reached 45°C., whereas in the case of the first combination it had reached 90°C.

In Fig. 4 the curves are shown for the relation between the coefficient of friction and the specific pressure for a number of antifriction materials. The tests were carried out under the same conditions as in the preceding case. The position of the curves shows that, compared with bronze and antifriction metal, the pseudo-alloys always have the lower coefficients of friction for the same specific loadings.

In view of the results of these friction tests, it can be said that the pseudo-alloys have proved superior to white metal and to bronze.

The high antifriction properties of the pseudo-alloys are due to the particular structure, namely, their marked heterogeneity, the microrelief nature of their surface, and the presence of pores. All this provides conditions for the easy running-in of the pseudo-alloys, and for the presence of a well-developed film of lubricant which is tenaciously held by the surface and which can be readily reconstituted when necessary. The ability of these bearings to operate under high pressures and at high sliding speeds is of particular importance.

A great deal of research has been carried out on the friction of bronze, tin-base bearing metal and of pseudo-alloys at high bearing pressures (increased in steps of 50 kg/cm^2), at a sliding speed of 3 m/sec., and in the presence of abundant lubrication. The shaft was of hardened steel.

The curves for bearing bronze (5 per cent tin, 5 per cent zinc, 4 per cent lead) and for the pseudo-alloys PStM15 and PMS30 are shown in Fig. 5. The shape of the curves indicates that as the pressure is raised, above 200 kg/cm^2 in the case of the bronze/steel combination, for example, there occurs a rapid and continuous rise of the coefficient of friction. In that particular case, the pressure of 200 kg/cm^2 must be considered as a limit above which the operation of the bearing combination becomes impossible since seizure under these conditions is only a matter of time.

In the same diagram, the curves for the pseudo-alloys show that as the pressure is increased, the coefficient of friction, after having reached a minimum value, remains constant for a certain time (curve for PMS30) or increases only slowly (curve for PStM15). The maximum permissible pressure for the bearing combination, including the pseudo-alloys, is between 350 and 500 kg/cm^2, i.e. it is 1·5 to 2 times that for the bronze.

Very often deterioration of bearings occurs as a result of poor lubrication of the sliding surfaces. Under these conditions, the ability of the bearing material to operate for a certain time without seizing in case of lubrication breakdown is of great importance.

In Fig. 6 are shown the curves obtained for the same bearing combinations as those tested above, but this time being run without lubrication.

The normal functioning for considerable periods of time of the bearing combinations, including the pseudo-alloys, was possible only because of the oil held in the pores of the pseudo-alloys. The amount of oil held in the pores proved sufficient to maintain the oil film during continuous operation of the bearing for 8 to 10 hr. under a pressure of 40 kg/cm^2. Afterwards the coefficient of friction began to increase, although even then fairly slowly.

Quite a different behaviour is shown by the bearing combination, including the tin-base bearing alloy. The coefficient of friction increases rapidly during the first few minutes of operation, and after 30 to 40 min. after the cutting-off of the supply of lubrication the bearing had seized.

Following upon the laboratory investigations, particular attention was given to the possibility of improving the mechanical properties of PStM15 and PMS30 pseudo-alloy coatings. This problem was successfully solved by V. F. Pichelson and A. I. Smolyaninov.[3] As a result of suitable heat-treatment, they obtained pseudo-alloys with properties approaching those of the original metals, while at the same time retaining to some degree the special characteristics of the sprayed pseudo-alloys. This heat-treatment enables an appreciable extension of the range of application of the pseudo-alloys.

Some typical applications of pseudo-alloys in the manufacture of bearing bushings and of bimetallic bearing shells are shown in Fig. 7.

Laboratory and works tests, the latter under widely differing conditions (machine tools, presses, engines), carried out over long periods of time, have shown the possibility of using the pseudo-alloys PStM15 and PMS30 as excellent replacement materials for bronzes and tin-base bearing alloys.

References

1 *Zhurnal Tekhnicheskoy Fiziki*, 1955, **25**, 5.

2 *Zavodskaya Laboratoriya*, 1952, **6**.

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NEW LABORATORY BLOCK EXTENDS RESEARCH FACILITIES

British Non-Ferrous Metals Research Association

WITH the completion of the first entirely new laboratory block the British Non-Ferrous Metals Research Association has been able to build since the war, most of the research work can go on in laboratories planned for the purpose, instead of in improvised accommodation pressed into use to keep pace with the Research Association's growing activities.

The main features of the new laboratory block are a much enlarged foundry, new corrosion and physics laboratories and a new electroplating shop, while alterations which have been made to existing buildings have enabled a new creep testing laboratory to be built to take over 100 units, the former mechanical testing laboratory to be converted into a fatigue laboratory and more space to be allotted to apparatus for the determination of gases in metals. An important feature of the rearrangements is the creation of space where temporary equipment can be installed for specific research projects as need arises.

Foundry Work

The old foundry, which contains a range of lift-out crucible furnaces, a bale-out furnace for die-casting work and a 600 lb. low frequency Ajax-Wyatt furnace for research into refractories for melting cupro-nickels, is now used solely as a melting and casting shop. Sand preparation, moulding, core making and so on are done in a new bay where there is a small moulding machine, two sand mills, shell moulding plant and apparatus for the CO_2 process. Vacuum and high frequency melting furnaces are housed in a small room off the main foundry.

Foundry research results show that even with traditional materials like gunmetals research pays. A systematic study has made it clear that the compositions used at present can be improved. For certain purposes, particularly where thick sections are involved, none of the gunmetals in common use is ideal, the best all-round combination of good mechanical properties together with ease of casting being obtained from an alloy outside the present ranges specified.

To help in formulating sensible standards for gunmetals, the B.N.F. is also making a detailed examination of the effect of the main impurities. Many foreign standards specify limits for a whole range of impurities, though there is little published evidence to suggest that they are harmful. Already the research has shown that sulphur, which is frequently limited in American and German standards for example, has no adverse effects even when present in quite large amounts: the influence of arsenic, antimony, bismuth and iron is now being investigated.

The majority of defective castings are the result of lack of attention to running, gating and feeding, both in light alloys and copper alloys. For some years, the basic principles of the design of good running systems have been under investigation for various typical castings made in different metals, and now the effort is being transferred to assisting members to apply the results to production castings.

A new research has been started on the casting and properties of high-silicon aluminium-silicon alloys which have recently been attracting attention in the motor industry, and other work in progress is concerned with improving the resistance to stress corrosion of the high strength cast aluminium alloys used in the aircraft industry. Some results of this suggest that L.M.10, the popular aluminium-magnesium alloy, can be improved considerably by small modifications to the composition.

Aluminium Alloys

To help the designer make the best use of aluminium alloys for land transport applications, a detailed comparison of the fatigue properties of medium strength light alloys and structural steels normally used in the transport industry is being made. Tests are going on not only with plain specimens but also with specimens having notches, the results of which will influence joint design.

Two Vibraphore direct stressing fatigue machines, one of 10 tons capacity and the other of 2 tons capacity, are in use for this work in a new fatigue laboratory which contains several other varieties of fatigue machines for tests under bending stresses. Some of these have been adapted for a rapid fatigue test on which the B.N.F. has been doing a considerable amount of development work. Fretting fatigue in connection with aluminium alloys is also being

The new moulding bay at the B.N.F.M.R.A. laboratories contains plant for sand moulding, the CO_2 process and shell moulding

investigated, and various anti-fretting agents are being compared.

A great deal of attention has been given to improving the transverse ductility of large high strength aluminium alloy extrusions and forgings now used in aircraft. The research has mainly concerned D.T.D.683, the aluminium-copper-zinc-magnesium alloy which has a high proof stress. The low ductility sometimes encountered across the direction of working has meant that unusual care has had to be exercised in using large extrusions and forgings.

In the Corrosion Section of the laboratories there are some interesting examples of the use of sprayed coatings of other aluminium alloys as a means of protecting high-strength aluminium alloys in corrosive environments.

Copper Alloys

A novel machine developed by the B.N.F. for correcting strip for various rolling faults is designed to be placed between the working rolls of the mill and the coiler. It helps to correct such faults as "waviness" and "spoutiness" and, in addition, equalizes the internal stresses in the strip. If there are uneven stresses, strip slit into narrow widths for presswork tends to take on a longitudinal curvature which causes jamming in modern press tools where the strip has to pass through a number of successive operations. The development of this machine has been one outcome of a research concerned with rolling copper alloys in which rolling loads for different alloys have been compared and the factors affecting the shape of strip during rolling have been evaluated.

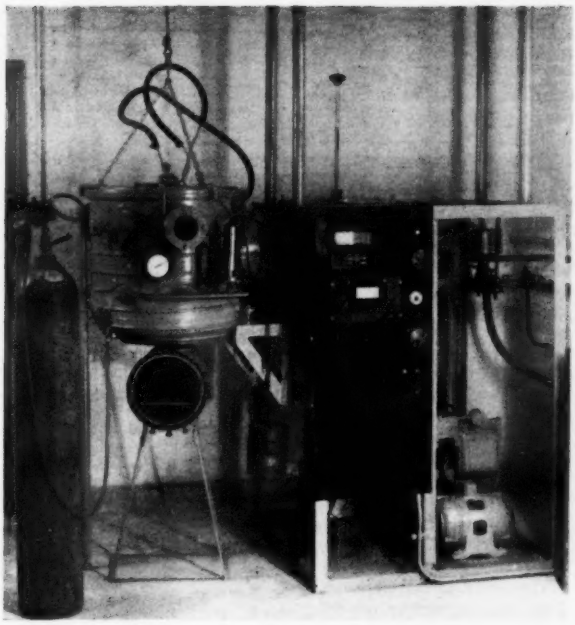
How much hydrogen is permissible in the atmosphere when bright annealing high conductivity copper and the reasons why adjacent turns sometimes stick together when bright annealing coils of wire or strip are being investigated in the General Metallurgy Section which has recently been extended.

Marine Corrosion

A new range of alloys is under development in the sea-water corrosion laboratory to meet the problems encountered with heat exchanger tubes in power stations and oil refineries built on tidal estuaries where highly polluted waters have to be used for cooling. Cathodic protection and wastage of ships' propellers are among other subjects being studied in this laboratory.

Lead-Clad Steel

A new B.N.F. product, lead-clad steel, combines the corrosion resistance of lead with the structural stability of steel and should lead to increasing use of lead in the chemical plant industry, where at present it is often applied by the costly process of hand burning. Industrial trials have proved that it is possible to make lead claddings up to $\frac{1}{4}$ in. thick on large steel plates which can be welded together without difficulty.



Furnace for making high-purity alloys by melting and casting in vacuum. The furnace was constructed in the B.N.F.M.R.A. workshops

X-Ray Fluorescence Analysis

Research on the metallurgical uses of X-ray fluorescence analysis has been going on at the B.N.F. for the past two years. The method is akin to spectrographic analysis, but instead of sparking the metal and examining the light spectrum produced, the metal is irradiated with a beam of X-rays and the X-ray fluorescence is split into a spectrum and analysed by means of a scintillation counter. By this means, the zinc content of brass can be determined in 1 min. with an accuracy at least as good as routine chemical analysis.

So far, the B.N.F.'s work has been confined to analysing brasses, tin bronzes and cupro-nickels in all of which the main elements can be determined accurately, but it is soon to be extended to other metals and to ores.

Instrumentation

Research is going on into several aspects of instrumentation. The one concerned with eddy-current testing is providing information about design of search coils for specific inspection problems. The development of a satisfactory radiation pyrometer for measuring the temperature of aluminium alloys during hot working is the objective of another research. The low and variable emissivity of aluminium makes radiation pyrometry particularly difficult. Researches of this kind are forming a background for an advisory service on instrumentation problems.

Newer Metals

Much of the B.N.F.'s work on the newer metals is now connected with the nuclear power industry, though research on titanium during the last 10 years has provided a good deal of basic information on the types of alloys from which creep resistance coupled with good forgeability can be expected. One laboratory is set aside for an investigation into the metallurgy of thorium and its alloys, the object being to produce thorium-based materials having adequate strength at high temperatures to be used as nuclear power fuel elements. In its unalloyed form thorium is insufficiently strong at the operating temperatures of a reactor, but some promising high-strength materials have been developed and their creep properties are being evaluated. Special creep testing equipment has had to be developed to enable the testing to be carried out in purified argon since thorium is too reactive to test at high temperatures in air.

Another research is concerned with the development of high-strength zirconium alloys which are of interest as canning materials for nuclear fuel elements, and the same type of creep testing equipment is being used. Work is also commencing on certain aspects of the metallurgy of the production of uranium fuel elements.

Metal Finishing

The new metal finishing laboratory is one of which the plating industry can be justly proud. At one end is a range of pilot-scale plating vats, with a polishing shop. The rest of the large laboratory is laid out with benches for small-scale work.

Work on the durability of nickel/chromium plating has shown that durability does not depend on the type of nickel used, and that modern plating baths can be operated for long periods without the durability of the nickel

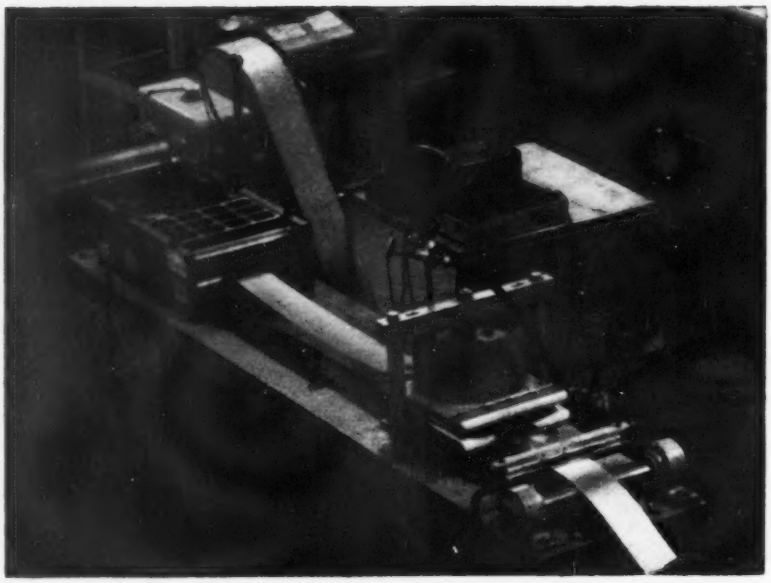
deteriorating, but that the life of plating out-of-doors is strongly dependent on the thickness of nickel applied. Here the B.N.F. coatings gauge looks as though it is going to be of great help in maintaining the reputation of the plating industry: it should not be long before the plater has an instrument suitable for routine inspection.

If it is much more than 0·00002 in. thick, the inherently good corrosion resistance of chromium is lost because of cracks. Means have to be found for making thicker deposits without cracks. Studies of the effect of altering solution concentration and plating conditions have suggested modifications allowing modest increases in thickness of chromium and the extra durability to be obtained from these coatings is being determined at the present time. For much of the work, plated zinc alloy die-cast motor car trim is being used.

Compounds labelled with radioactive tracers are proving useful in fundamental work designed ultimately to improve nickel plating solutions. It is known that the complex organic substances added to modern nickel plating solutions to give the deposit such qualities as smoothness and brightness while retaining reasonable ductility, become incorporated in the nickel to some extent, though the amounts involved are too small for ordinary chemical analysis. With typical addition agents specially prepared by the Radio Chemical Centre with a radioactive isotope such as carbon C_{14} or sulphur S_{35} as tracer, the extent of incorporation of the organic agents can be determined by checking the deposits with a Geiger counter.

High Temperature Brazing

Brazing of high temperature alloys such as Nimonics is being studied in the B.N.F. laboratories. The work covers fundamental aspects such as joint design and method of heating necessary to ensure complete soundness of joints, the correct combinations of brazing metal and basis metal for different circumstances and the high-temperature strength of the joints. Work on brazing titanium alloys where similar problems are encountered has just started.



Strips being treated in a prototype roller-stretcher machine for correcting edge curvature and other rolling faults

Non-Ferrous Metals in Building

One of the most important uses of non-ferrous metals is in handling water supplies and there are several researches in progress in the Corrosion Section concerned with this. The evaluation of aluminium alloys for conveying water supplies has shown promising results for clad tubes and arrangements have been made to test these materials in plumbing installations.

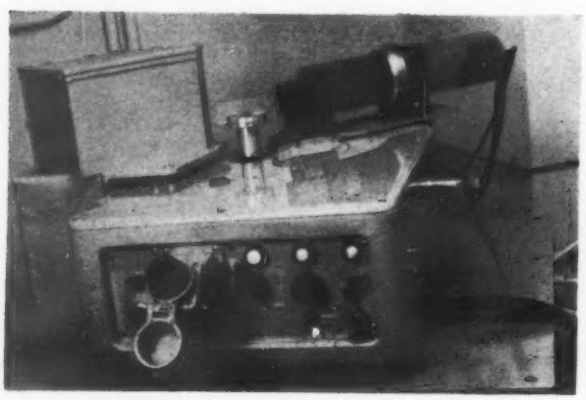
A room is set aside for a major effort to develop improved galvanized coatings for hot water tanks. Twenty miniature tanks, each fitted with a small external electric boiler to simulate a hot water circuit, are being used to test modified coatings as well as to determine the important conditions to ensure a long life from galvanized tanks. In the meantime, field tests at some fifty sites have demonstrated the value of magnesium anodes for preventing early failure of tanks where the water is unusually aggressive.

Two researches are in progress in connection with the use of copper alloys in supply waters; one an investigation of the dezincification of hot pressed brass fittings which has been a trouble in a few areas in the country; the other a research into the pitting corrosion of copper water pipes. The fact that this pitting is usually caused by films formed in the bores of tubes during manufacture was established some time ago and prominence has been given to helping manufacturers avoid them.

Greater use of metal for decorative panelling in buildings has led to the commencement of a new research to find a means of preserving the natural appearance of copper and its alloys.

Lead Cable Sheathing

Despite competition from other materials, lead is still the most important cable-sheathing material. The chief requirements are good resistance to fatigue cracking for sites where there is vibration, ductility and ease of extrusion. The B.N.F. has recently patented a range of dilute lead-antimony based alloys which look as though they will fulfil these requirements better than any of the alloys in current use. Laboratory tests of experimental commercially extruded sheaths in these alloys have been in progress for two years and arrangements for field trials have just been made. The possibility that the same basic composition in varying degrees of dilution could fulfil practically all requirements offers a great advantage when cable presses are being changed from one type of production to another.



An X-ray spectrometer built in the workshop for research on X-ray fluorescence analysis, a comparatively new technique potentially capable of analysing accurately complex alloys, ores and slags in a matter of minutes

BATCH-TYPE FURNACE FOR ANNEALING PRIOR TO COLD ROLLING

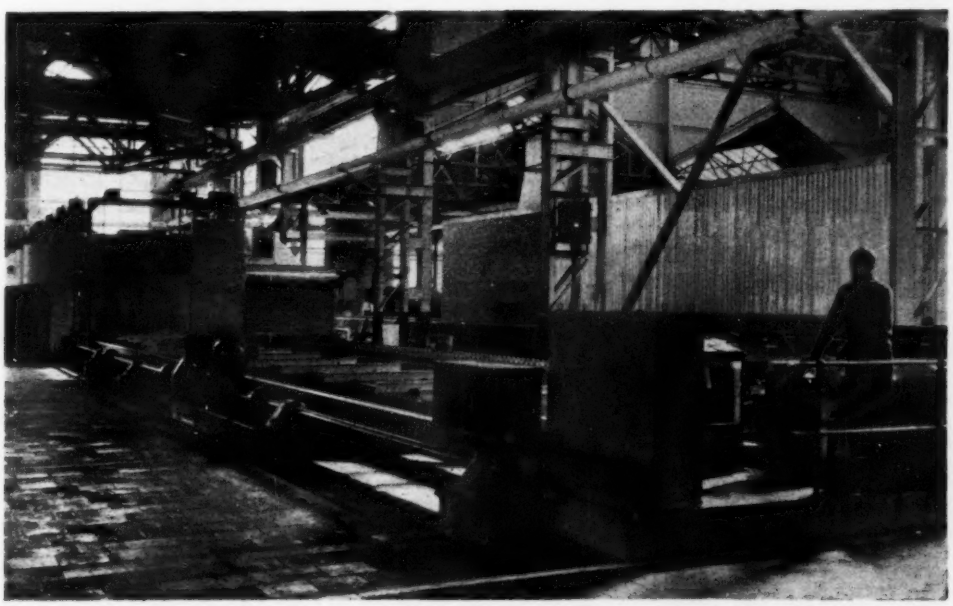
Heat-Treating Long Aluminium Slabs

INCLUDED in a large-scale development programme at the Northern Aluminium Company Ltd. involving the introduction of much new plant and handling equipment, was the installation of a new batch-type furnace for annealing 65 ft. long aluminium slabs. The furnace was designed and erected at the Banbury Works by G.W.B. Furnaces Limited, of Dudley, Worcs. Previously, the Banbury mills engaged in rolling aluminium sheet could roll a maximum width of 5 ft.; now the new mills can produce widths of up to 6 ft. 6 in., and the G.W.B. furnace has been specially designed to fit in with this new development. Ingots of aluminium 8 in. thick are hot rolled down to approximately 0·3-0·5 in. Some work hardening takes place and, consequently, slabs have to be annealed before being cold rolled to lighter gauges. The slabs which are treated in the G.W.B. furnace are normally heavy duty materials for use in aircraft and also coachwork and decorative finishes, car trimmings, etc. The furnace can accommodate loads up to 16 tons for slab lengths of 65 ft. and widths of 6 ft. 6 in.; the maximum temperature is 600° C., although normal operating temperatures are somewhat lower. A three shift system is at present being worked. The furnace has a rating of 1,000 kW, arranged in six independent and automatically controlled zones, of equal length, distributed as follows: Zone 1—220 kW, Zones 2 to 5—150 kW each, Zone 6—180 kW. The high rating enables cycle times of as low as 4 hr. to be achieved.

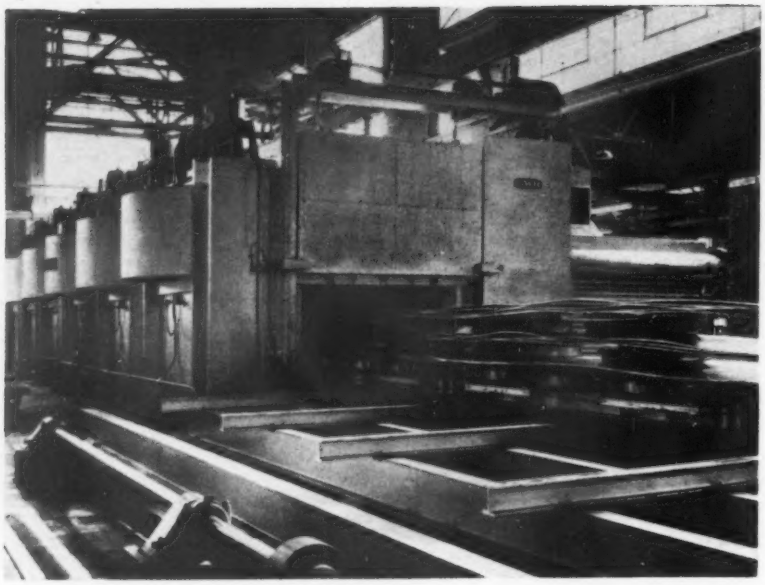
The heating chamber is lined throughout with heat-resisting alloy, backed by a thick wall of Moler insulating bricks, thus reducing heat losses to a minimum. A robust understructure supports the furnace clear of the ground, and permits free air circulation under the hearth. A cast framed, refractory faced, fully insulated and counterbalanced door, driven by electric motor, minimizes heat losses at the furnace entrance. Heating elements of high-grade nickel-chromium strip, arranged upon removable plugs, are situated in the roof of the chamber, and each zone is fitted with a forced air circulation system, directed cross flow from the fan, through the heating elements contained in the ducted portion of the heating chamber, down into the treatment chamber, and back into the fan for recirculation. A double cased baffle of heat-resisting alloy, packed with a layer of insulation, is fitted in the roof of the chamber, separating the heating elements from the actual working area, thus preventing radiation on to the charge. The elements are suspended edge-on to the air stream between the roof and the insulated baffle by a hook suspension method, ensuring maximum support and preventing "element flutter." On each side of the working chamber, a system of equally spaced and parallel baffles extends fully down the length of the chamber. Each baffle is independently adjustable to direct the air flow in such a manner as to give the desired flow characteristics and equalize the temperature throughout the working chamber. A section of the insulated fan scroll is removable to facilitate inspection of both the heating elements and the fan unit. Six air circulating fans are fitted, one per zone, each fan capable of delivering 30,000 ft^3 of air per minute. Each fan unit may be withdrawn through the side of the furnace casing.

With heat-treatable alloys, in order to obtain fully-annealed material, a slow cool is essential. To ensure this, a cooling chamber, similar in size to the heating chamber, has been incorporated in the installation. The cooling chamber comprises a rigidly constructed framework fabricated from rolled steel sections covered with non-combustible asbestos panels. The door is of the roll-up, flexible slat type, with electrical drive and push-button control. Six fan units are again provided, one per zone, with the necessary ducting to direct the air flow into the chamber. A splitter plate is arranged in the roof of the chamber so that the air flow is directed down one side of the chamber, through the charge, and then back up into the fan eyelets for recirculation.

A G.W.B. single track charging machine serves both the furnace and the cooling chamber. It is designed to work in conjunction with the roller fitted charge skips. The machine is of very heavy construction, being mounted upon three rows of rail wheels for traversing, and a "go-getter" facilitates charging and discharging. The overall length of the furnace and



Overall view of G.W.B. annealing furnace for 65 ft. long aluminium slabs, with cooling chamber on the right and charging machine in the foreground



Aluminium slabs being loaded into the G.W.B. annealing furnace at the Banbury works of Northern Aluminium Co. Ltd.

charging machine is approximately 160 ft.

Temperature control in such processes is critical, and this is provided automatically through a G.W.B. instrument cubicle. Six Integra, Leeds and Northrup indicating controllers are provided, one for each zone, and a six-point recording instrument allows a positive visual check on thermal conditions throughout the process cycle. A Venner 15-day automatic time switch is incorporated in the panel, together with six green lamp bezels indicating which element zones are on, and one red lamp bezel labelled "Equipment Alive." The switchgear is contained in a separate G.W.B. contactor cubicle, and comprises six furnace zone triple pole contactors, six fan motor contactors, and one door drive motor contactor. Adequate protective devices are incorporated; safety contacts are arranged to cut off the supply to the heating elements, in the event of accidental overheating; a limit switch is fitted to the furnace door, cutting off the supply to the heating elements when the door is in the raised position, and one Ellison oil-immersed circuit breaker allows the whole installation to be rendered "dead."

Research on Spring Materials

AT the annual general meeting of the Coil Spring Federation Research Organization, two Papers were presented, one, by Mr. J. K. Bache, on future technical requirements of the spring industry, and the other by Mr. R. Haynes on the past year's research programme. Mr. Bache referred to the need for a high-strength aluminium alloy capable of being used for springs, and looked forward to more experience of electroplating on steel wires without loss of properties. In discussion, Dr. R. Genders referred to new sources of beryllium, and Mr. G. C. Nutting felt that better instrumentation for flaw detection in wires was needed.

In the second Paper, Mr. Haynes reviewed work on the copper-beryllium alloys, emphasizing the importance of control in heat-treatment. Work had been done on the effects of variation of beryllium content and on grain size. Future work would be directed towards investigating the characteristics of beryllium-copper-cobalt alloys. Some of the gaps in the existing knowledge of brass spring wire had been filled by recent work and the advantage of straight drawing over drawing and coiling had been proven and the benefits of a low temperature heat-treatment demonstrated. Three commercial titanium alloys were available in wire form and their static and fatigue properties had been determined. Other work of the Research Organization included investigations into the directional properties of spring strip, particularly the properties of cross-rolled strip. Work on electroplating, peen plating and vacuum deposition was also being initiated.

Stressing the values of research on beryllium-copper, Mr. D. A. Oliver also mentioned a new wire material—molybdenum-rhenium.

Men and Metals

At the 1959 Congress held in Scheveningen recently, **Dr. Joseph Husler** was re-elected President of the Bureau International de la Récupération.

Two new directorial appointments have recently been announced by Crofts Engineers (Holdings) Limited. **Mr. J. Busfield,** A.C.A., has been appointed a director of Crofts Engineers (Holdings) Limited, Crofts (Engineers) Limited, and J. Parkinson and Son (Shipley) Limited. **Mr. M. T. J. Goff** has been appointed a director of J. Parkinson and Son (Shipley) Limited.

At a board meeting held last week, Harrison (Birmingham) Limited appointed **Mr. A. M. Brookes** secretary in place of **Mr. Philip Green,** and **Mr. R. J. Falconer** was appointed registrar. Mr. Green remains the director in charge of sales.

General manager of Chamberlain Plant Limited, **Mr. W. P. Mullen** will be visiting European and Mediterranean countries on a fact-finding and market assessment tour.

Attending the British Trade Fair in Lisbon in his capacity as President-Elect of the British Iron and Steel Federation, **Mr. Richard F. Summers,** with his wife, will receive guests at a cocktail party arranged by the Federation at the Avis Hotel, Lisbon, on Tuesday next.

As part of the expansion of their sales organization, the Cambridge Instrument Company Limited has appointed **Mr. I. H. Gordon** assistant sales manager at their head office in London. Mr. Gordon commenced his new duties at the beginning of March last.

Holding Aluminium

TO help light metal foundries casting aluminium and aluminium alloys, the Electric Resistance Furnace Co. Ltd., Weybridge, Surrey, have introduced a heated crucible cover fitted with solid rod heating elements operating at low voltage. This lid is designed to maintain the temperature of liquid aluminium in the production of high quality metal, either by holding at temperature for several hours, or by inducing into it during the holding period, nitrogen or dried chloride gas.

The elements enable much higher loadings to be used, and a greater intensity of heating to be obtained over a small surface area than do conventional wire or tape elements.

The heated lid can be made to fit existing holding pots of normal capacities or, alternatively, complete crucible assemblies can be supplied.

New Plant & Equipment

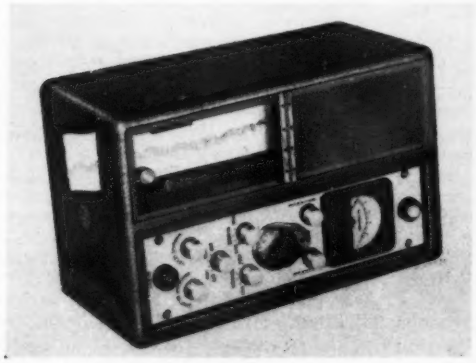
Flaw Detection

AN addition to the range of non-destructive testing apparatus is the Introview non-destructive flaw and corrosion tester, originally developed by Imperial Chemical Industries Ltd. and now manufactured under licence and marketed by the Sperry Gyroscope Co. Ltd., Great West Road, Brentford. Intended primarily for manufacturing plant, eddy current inspection methods are now also being applied to aid the engineer in detecting the presence of flaws, corrosion, thinning, etc., in such processes as steam generation and oil refinery plant where large numbers of non-ferrous tubes are used under severely corrosive conditions. Utilizing this technique to the full, the Introview probe can be pulled through the tube at high speed (120 ft/min.) to give a clear assessment, on continuous and permanent record, of the tube condition.

For the inspection of long tubes, a compressed air probe injector and winching unit facilitate high speed testing and up to 250 20 ft. long tubes can be tested per hour by a team of two operators. Where condenser and heat exchanger units are to be tested, this high rate readily permits a 100 per cent check to be made with minimum shut-down time, thereby giving a reliable record of the condition of the whole plant and avoiding the assessment on the results of a small number of sample tubes. As speeds of recording and winching the probe through the tube are proportional to one another, accurate location of flaws can be made simply with reference to the chart.

Probes for special applications, both internal and external, are available or can be made to suit customers' requirements. Considerable attention has been paid to the production of a robust and reliable instrument that may be easily transported to the test location and quickly set up by operators with no special technical qualifications, so that the time taken on the job is spent in testing tubes and not the test equipment. The circuit arrangements of the Introview are such that accurate recordings are made even under power supply fluctuation conditions of up to 20 per cent.

Trace interpretation may be carried out by comparatively unskilled operators and, as these traces are permanently recorded, reference may be made to previous tube conditions so that the periodic checking of the plant can be planned over the useful life of the tubes. In this way, unnecessary testing may be eliminated by building up a standard "library" of charts relating to certain types and wall thicknesses of tube operating under certain fixed conditions, from which the expected life of any given installation may be easily and accurately assessed.



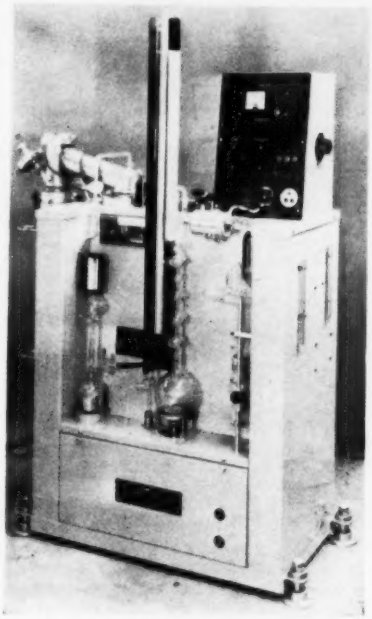
Left: The "Introview" non-destructive flaw and corrosion detector. The recorder gives three forms of indication: milliameter, reject lamp and chart. The continuous chart is used to give a permanent record of tube condition

Right—External search coil of "Introview" allows a high speed check to be made on all material passed through it and is particularly applicable to continuous inspection on production; a range of other probes and coils is available

Gas Analysis

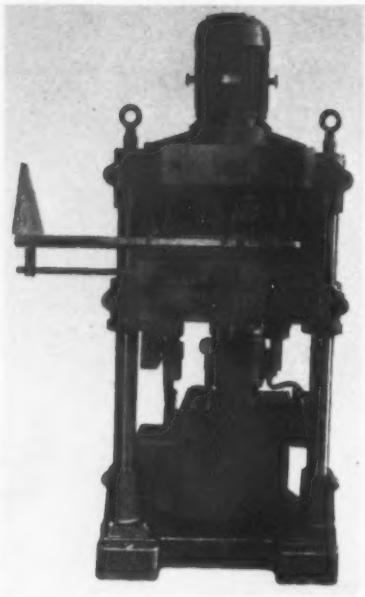
GAS analysis of metals by vacuum fusion is a widely-known technique and has a number of advantages over conventional wet methods of analysis. The latest production version of the Edwards vacuum fusion apparatus is highly advanced equipment for macro determination of gases in steel and other metals, and the prototype was tested by the British Iron and Steel Research Association for several years.

The apparatus is exceptionally compact, and glasswork has been reduced to a minimum. The most modern vacuum pumps and vacuum engineering methods have been used, resulting in a number of novel features. The major advantage concerns the use of the "Speedivac" 2M4 mercury diffusion pump, which has a high compression ratio. With a limited backing pressure of 35 torr, the 2M4 can extract a large mass of gas from the furnace and compress this into a very small collecting space. Its high pumping speed, 75 L/sec., also ensures that this gas is extracted quickly, thus reducing the "getter" effect from evaporated metal films. A further advantage of such a system, using a small collecting space, is the absence of large surface areas, thus reducing a source of additional outgassing.



Edwards' vacuum fusion plant for gas analysis showing furnace tube projecting from left of equipment. R.F. heating equipment not shown

The furnace comprises a water-cooled stainless steel head with a clear silica furnace tube, 2¼ in. in diameter, cooled by means of water circulation within a clear plastics case surrounding it. The silica tube houses a graphite crucible and graphite powder insulation, together with a mechanically-operated graphite stopper, working from an external electrical drive. Samples of up to 10-15 gm. of steel can



The Inca multi-spindle spin-riveting machine

be accommodated, and the power requirement for specimen melting is of the order of 10 kW R.F., applied via a high frequency coil placed around the plastics tube, producing a maximum crucible temperature of the order of 2,400°C. This power source and suitable coil are not included with the apparatus, but suitable equipment can be obtained from Radio Heaters Ltd., of Wokingham. Both the silica furnace tube and the plastics outer cover are securely held by means of a quick release gripper, using compressible synthetic rubber seals.

Attached to the furnace head is a specimen holder consisting of a vacuum lock, for charging the furnace without loss of vacuum. The head is fitted with a clear silica window which is protected from evaporated deposits by means of a movable nickel shield.

The gas collecting line is connected to a glass Toepler pump of approximate volume 1,000 c.c., the ratio of the Toepler pump volume to that of the collecting line being approximately 8½:1. A 90 cm. mercury manometer is provided as a reference level in order to use the Toepler pump as a McLeod gauge when measuring collected gas pressures. The minimum quantity of gases that can be detected by this equipment is less than 10^{-5} gm. for hydrogen, oxygen and nitrogen, readings being taken at 20°C.

From the Toepler pump, the collected gases may be either expelled into a vessel for separate analysis or, if the analysis section is fitted to the equipment, may be circulated and dealt with in it.

Complete instrumentation for all necessary pressure measurements is built into the equipment. A McLeod gauge, range 0·1 torr to 0·00001 torr, is permanently connected to the furnace head, and a "Vacustat" tilting McLeod type gauge, together with a Pirani type vacuum gauge, both covering a range of 0·5 torr to 0·001 torr, are connected to the backing pressure system. A control panel is provided on the cabinet to accommodate all electrical controls as well as the Pirani type vacuum gauge.

The equipment is neatly housed in a metal cabinet with a recessed front to protect the small amount of glasswork that is used. The stainless steel furnace unit projects from the left, melting being carried out by separate high frequency unit, which can be supplied if necessary. The apparatus is produced by Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex.

Spin Riveting

DESIGNED primarily to secure a die-cast moulding to a motor car dash panel by simultaneously spin riveting eight rivets, a multi-spindle spin-riveting machine has been introduced by The Inca Engineering Co., 1287 High Road, Whetstone, N.20.

The machine basically comprises a multi-spindle head, fitted with spinning tools and mounted upon pillars, with a hydraulically-operated table to feed the component towards the multi-head.

The operator is merely required to load the moulding and the dash panel into the location nest and then depress the lever to start the automatic cycle.

A pressure plate ensures that the two components are held closely together during the spinning cycle.

The scope of the machine is not limited to spinning, as it is ideally suited for drilling, tapping and reaming. By reason of the mounting of the multi-head, deflection during heavy drilling is negligible as compared to conventional types of machines.

The ease with which multi-heads can be changed for various components is extremely advantageous for batch production. Table strokes and sizes of driving motor can be varied to suit customers' requirements and, by virtue of the design, the daylight between the multi-head and the table is limited only by the practical length of the twin columns.

Temperature Control

A TEMPERATURE controller of simple operation, with no moving parts, the C.N.S. saturable reactor type proportional temperature controller provides close control of furnace temperature without the additional cost of the variable mains transformer, the mains shunt resistance and the relay, which are standard in most furnace control equipment.

The controller, a product of C.N.S. Instruments Ltd., 61 Holmes Road, London, N.W.5, is operated by a resistance thermometer whose change of resistance with temperature is used in a bridge system to give a continuously variable current which governs the output of a saturable reactor or transductor. This controlling current varies from 5 to 100 mA D.C. with a load of 2,500 ohms maximum.

The controller is used in conjunction with a reactor of suitable size for the particular furnace (generally ¼, 1, 1½ or 2 kVA). Used with a 1 kVA reactor, the power supply to a furnace can be set from 200 VA to 1 kVA by adjustment of the bridge precision potentiometer. After this setting, any variations in the resistance of the thermometer due to temperature changes in the furnace will readjust the current to maintain constant temperature. A 1 per cent change in absolute temperature is sufficient to swing the control current from its maximum to its minimum value, and temperature errors which would occur without the controller are reduced by a factor of 600 approximately, whether they are due to mains voltage variations, ambient temperature changes, or varying thermal constants. This means that the overall effect of a mains voltage change of 5 per cent on a furnace operating at, say, 700°C. can be reduced to within ±0·2°C.

Compensation for mains voltage variations is provided and transient errors in temperature due to thermal lag are reduced to a minimum.

Saturable reactors are available with the controller which will enable almost any furnace or oven to be run directly from the main supply, whether 110 V or 240 V, and the need to switch or control all or any part of the current to the furnace is completely unnecessary.

Setting of the furnace temperature requires the operation of one control knob only, and the range of temperature which can be covered, using only one resistance thermometer, is approximately 800°C.

Obituary

Mr. W. Williams

IT is with regret we record the death of Mr. William Williams, chairman of Sklenar Furnaces Ltd. since its formation. After an apprenticeship in the foundry trade, he set up in business on his own, his main output at first being railway wagon bearings. By 1926 he had established a flourishing non-ferrous foundry, and in 1932 the Williams Alexandra Foundry moved to its present site in East Moors Road, Cardiff, and subsequently several subsidiary companies were formed.

Mr. Williams was a strong supporter of the Institute of British Foundrymen and kindred associations, and in 1932 he was the Branch President of the South Wales Branch of the I.B.F. He was also a member of the South Wales Institute of Engineers and a member of the Institute of Metals.

Industrial News

Home and Overseas

Anniversary Gift

An interesting ceremony took place at the Smethwick works of **Evered and Company** last week during the visit of the Mayor of Smethwick, Councillor J. Randle. To mark the 150th anniversary of the firm the Mayor was presented with a silver coffee set. In making the presentation, Mr. W. L. Burrows, chairman of the company, paid tribute to the loyalty of the locally recruited workers.

Lead Developments

In its review of services for the year 1958, just published, the **Lead Development Association** describes how important steps were taken during the period to consolidate the fundamental developments in its *modus operandi* which occurred during the previous 18 months. Considerable headway was made by the Association during the period under review in the sphere of international relations, and some account is given of the general manager's visit to the United States and Canada, and of his tour to effect contacts with friends and counterpart organizations in Holland, Germany, Belgium and France.

The review includes a reference to the United Nations Conferences on Lead and Zinc, held in London and Geneva, at which the Association was represented. Finally, the work of the Lead Sheet and Pipe Section of the Association is described in some detail. There are also a number of illustrations and five appendices.

Import Duties

The Treasury have made the Import Duties Drawbacks (No. 5) Order, 1959, which provides for the allowance of drawback of import duty paid on certain plated metal drinking cups when the cups or goods incorporating them are exported. The Order came into operation on Wednesday last, June 3, and has been published as Statutory Instruments 1959, No. 921.

Nuclear Equipment

Setting up of an Anglo-American company to specialize in the design, manufacture and marketing of remote-controlled nuclear handling apparatus has been announced jointly by Savage and Parsons Ltd., of Watford, Herts., and General Mills Inc. (Minneapolis, U.S.A.). The new company, to be called Nuclear Equipment Ltd., will have its head office at Otterspool Way, Watford. The company will be concerned with both mechanical and powered manipulators, reactor fuel, loading and unloading systems, reactor maintenance systems, and other types of handling apparatus and ancillary protective equipment.

Zinc Smelting in India

An electrolytic zinc smelter is to be set up near Katras in Dhanbad district, it is learned. This would obviate the necessity of sending zinc concentrates for smelting to Japan. The installed capacity of the smelter will be about 14,000 tons a year.

The smelter will be set up under an expansion programme of the Metal Corporation of India. The programme envisages increasing production of zinc concentrates, sulphuric acid and superphosphates. It aims at doubling lead production from 4,000 tons to 8,000 tons a year. Its output of silver is also expected to be doubled from 350,000 tolas to 700,000 tolas annually.

Contracts Received

In connection with the new cold strip mill which is being installed by Steel, Peech and Tozer Ltd. at their Brinsworth plant, and which was the subject of a news paragraph in these columns on May 15 last, we are now informed that **Sir James Farmer Norton and Company Ltd.** have received orders for the skin pass mill which is to work in conjunction with the other strip mill plant being installed.

New Welding Guns

In conjunction with Aluminium Laboratories Ltd., **Northern Aluminium Company Ltd.** have carried out tests and development work on a new system of M.I.G. welding, using self-feeding guns that themselves carry a small spool of wire, instead of a much larger spool being located some distance away.

This means that the wire, instead of being pushed through distances of perhaps 10 ft., has only to be pushed about 3 in. and, consequently, a much thinner wire can be used. It is understood that this fine-welding system has been successfully used in America for about four years, and one American gun, together with the attendant electrical equipment, is now being marketed in this country by Rowen-Arc (Division of Rubery Owen and Co. Ltd.) under the name "Rowen-Gun." This can feed wires down to 0·020 in. in diameter, and so will extend the useful range of M.I.G. welding to materials as thin as 0·036 in.

Apprentices' Evening

It has been announced by the **Association of Bronze and Brass Founders** that the competition arranged for London bronze and brass foundry apprentices in the area has now been held. Fourteen apprentices took part and the venture is stated to have been very successful.

A meeting of members in the London area, to which the competitors have been invited, is to be held at the Clarendon Restaurant, Hammersmith, London, on the evening of Wednesday, June 24 next, commencing with dinner at 6.30 p.m. The meeting will be devoted to apprenticeship matters and there will be a commentary on the castings entered for the competition.

A Removal

Extensive new premises have recently been taken over by **Stedall and Company Ltd.**, and **Farmer, Stedall and Company,** for their metals warehouse. This building is at St. John's Wharf, Carnwath Road, Fulham, London, S.W.6, and houses the whole of the two companies' iron and steel, aluminium and aluminium alloy sheets and extrusions, brass, copper, metal-faced plywood, hardboard, and Dexion angle, etc.

Greatly improved facilities have been achieved by this move, as there are extensive loading bays for commercial or private vehicles' collection of materials.

Laboratory Equipment

Two pieces of laboratory equipment which are stated to be new to this country have recently been introduced by **Glen Creston Ltd.** One is the Micro Mixer Mill for extremely rapid disintegration and mixing of minute quantities of substances to ultra-fine particle size. The grinding and mixing is carried out in stoppered vials of 2 or 5 c.c. capacity, made of plastics, stainless steel, hardened tool steel or agate.

The other equipment is the Sample Mixer Mill, which basically serves the same purpose but is capable of coping with very much larger quantities. This unit is a high speed impact shaker, designed for mixing and grinding laboratory size samples quickly, conveniently and uniformly.

Tin Export Quotas

Third quarter tin export quotas under the International Tin Agreement are to be raised to 25,000 tons from 23,000 in the previous quarter, according to the official communique issued after the end of the Council's eighteenth meeting.

The Council also decided to extend the Buffer Stock Manager's authority to operate within the middle price range in the agreement—namely £780 to £830 per ton, to the end of the seventh control period.

The Council disclosed that Buffer Stocks at the end of December totalled 23,325 long tons.

The Council and the United Kingdom Government agreed in principle that arrangements would be made for the disposal over an unspecified period of 2,500 tons of tin from non-commercial stocks of the United Kingdom Government through the agency of the Buffer Stock Manager.

The Council approved the re-allocation of the votes of the consuming countries for the year 1959-60. It also considered re-allocation under the agreement of one-twentieth of the percentages of the producing countries and approved the following percentages operative from July 1, 1959: Belgian Congo and Ruanda-Urundi 9·05, Bolivia 19·40, Indonesia 18·90, Federation of Malaya 37·75, Federation of Nigeria 6·10 and Thailand 8·80 per cent.

The next meeting of the Council will be held in London on September 1, 1959.

British Plant for Poland

As a result of negotiations with the Polish Government Agency Centrozap, and following visits to Poland by Head Wrightson's staff, an order has been placed with the **Head Wrightson Machine Company Ltd.** for two hot dip tinning lines, valued at approximately £180,000 and designed to give an average output of 10,000 tons of tin plate annually. This new plant will treble Poland's present output of tin plate.

The contract, which was won in the face of European competition, was signed

in London after a delegation of technicians from Huta Lenina, the largest and most modern steelworks in Poland, had visited South Wales to see the company's equipment in operation. Delivery of the equipment will be completed in 12 months.

U.S. Stockpile Sales

News from Washington is that 13 United States Senators last week sponsored new legislation to ensure that the 1,000 million dollar Defense Production Act stockpile cannot be liquidated without prior Congressional approval. The legislation would prevent the disposal of copper, among other strategic items, on the open market. At present, the executive branch does not need prior Congressional approval to unload the inventories acquired under the 1950 Defence Production Act, although approval is required to dispose of some 75 key industrial materials in the basic "national" stockpile and the so-called "supplemental" stockpile.

Developments in Rhodesia

Plans for the development of a small copper ore body about a mile and a half to the west of the copper-cobalt mine of Chibuluma in the Northern Rhodesian copperbelt were announced last week by Chibuluma Mines Limited of the Roselite Group. The ore body, known locally as Chibuluma West, contains about two million tons assaying 4·81 per cent copper. It will be mined as part of the Chibuluma enterprise. Development work, estimated at £850,000, is expected to start immediately with production scheduled to begin in 1963.

This western ore body and the existing one at Chibuluma will be mined concurrently. The combined tonnage can be treated in the existing concentrator at Chibuluma and will mean an increase in production of 4,000 long tons a year. The Chibuluma West ore body, 8,000 feet to the west of Chibuluma's Norrie shaft, was discovered by drilling in 1941. As with the main Chibuluma ore body, there were no surface indications of ore other than the presence—in pits—of what was regarded as a favourable horizon. Further drilling of much more closely spaced holes was commenced in 1957 and resulted in the outline of the present ore body. In his annual statement last October Sir Ronald Prain, chairman of the Roselite Group, recorded that the occurrence appeared to amount to about one million tons at 4·05 per cent copper. This has since been increased to two million tons assaying 4·81 copper.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses at the end of last week fell 451 tons to 7,664 tons, distributed as follows:—London 4,809, Liverpool 1,970, and Hull 885 tons.

Copper stocks rose 1,382 to 12,898 tons, and comprised London 2,397, Liverpool 5,419, Birmingham 1,025, Manchester 3,800 and Hull 257 tons.

Tin Council Decision

Mining circles in North Malaya welcomed the decision of the International Tin Council to raise the permissible export quota to 25,000 tons in the third quarter from 23,000 tons in the previous quarter. Mr. P. A. Delme Radcliffe, President of the Federated Malay States Chamber of Mines, said he thought this further increase in the permissible export amount would be very welcome to tin producers in Malaya. The increase could be regarded as an indication of the confidence the International Tin Council and its member countries had in the effectiveness of the measures taken. Mr. Woo Ka Lim, a Federal Councillor and a leader of the Chinese producers, said the future seemed bright, and they hoped the improvement would continue.

A general view of the exit ends of nine hot dip tinning lines, similar to those to be supplied to Poland by Head Wrightson Machine Company Ltd.

The Millionth Ton

On Wednesday, May 20 last, the chairman of United Sulphuric Acid Corporation pressed a button releasing the millionth ton of anhydrite from the Long Meg Mine, near Penrith, into a railway wagon specially decorated for the occasion. This millionth ton represents the output of the mine in the last four years and achieves the target of a quarter of a million tons annually which was set when the development project was started.

Eire Copper

Old copper mines on Ross Island, Killarney, were visited last week by Mr. P. E. Auger, a Canadian geologist, who was accompanied by an official of the Eire Geological Department. Some time ago it was announced that survey work on this site had ceased. The copper mines on Ross Island were last worked commercially in 1804, when ore valued at about £80,000 was mined there. Flooding in the mines by lake water ended the venture. The property is owned by a group of Americans, who purchased a portion of the Killarney Estate a few years ago.

Ejector Pins for Die-Casting

For some years the **Coatham Engineering Co.**, of Wolverhampton, have been producing a standard range of ejector pins for die-casting dies. Increased demands for high-temperature resistance and freedom from scoring have led to the introduction of two new qualities—"Pyromax" and "Vanacrom." The former are of nitrided chrome steel in a range from $\frac{1}{8}$ in. dia. to $\frac{1}{2}$ in. dia. The latter are heat-treated chromium alloy steel and are especially suitable for core pins, the size range being similar. Made in 6 in. and 10 in. lengths, they can readily be cut to shorter lengths as required.

Aluminium Sales

United States aluminium sales and production continue to mount. Industry sources said the bulk of the improvement in demand was due more to a rise in actual consumption than to hedge buying against the possibility of strikes or price rises this summer. These two factors could not, however, be entirely discounted as buying incentives. The self-imposed price freeze on primary metal and aluminium products expired on June 30, these sources said, and industry-union contracts expired a month later. Steel and copper wage negotiations were expected to set a pattern for the new aluminium contracts, the sources added.

Sir Ronald Prain on Copper

Speaking at the annual dinner of the Northern Rhodesian branch of the Institution of Mining and Metallurgy, Sir Roald Prain said that the United States was pouring thousands of millions of dollars into underdeveloped countries to counter Communism, yet her copper producers were not allowed to enter into agreements with these countries to stabilize the copper price and keep it in a profitable range. It was absurd that the whole of the work done by these thousands of millions of dollars could be undone by anti-trust laws.

Sir Ronald said he agreed with the Chilean Government, who were pressing for the anti-trust laws to be changed in such a way that their copper producers would be allowed to discuss with other world producers how to maintain the price of copper at a reasonable level and ensure that underdeveloped countries would not enter into depressions which, in turn, could only lead to Communism.

Until such arrangements could be made, the copper market depended for its

behaviour on voluntary discipline. Sir Ronald referred to the time when the R.S.T. group had attempted to fix the price of copper at £280 a ton. He said he would like to think that, if world producers on that occasion had also agreed to fix the price of copper, we should not have seen the price drop to £160 a ton. If this situation occurred again, one would find a very different set of conditions, because the copper price would be maintained, if possible, by the world's producers.

Tungsten Processing in Korea

A modern tungsten processing plant, capable of processing tungsten middlings into high percentage scheelite amounting to 5,000 tons a year, has been completed at San Dong, South Korea. Built by the United States Utah Construction Company at a cost equivalent to £1,280,000, the synthetic scheelite plant will raise the percentage of tungsten components to 90-95 per cent from the current 60 per cent. The plant is managed by the State-owned Korean Tungsten Company. The company's tungsten mine is one of the largest mines in the world, with known ore reserves of about 5,000,000 tons.

Tungsten has been South Korea's major export commodity during the past eight years. The company in the past used an acid processing method, with unsatisfactory results in eliminating such impurities as molybdenum and sulphur in the tungsten component. The new plant will solve this problem.

Tin Shipments

Tin shipments from Singapore during May totalled 15½ tons, according to the Straits Trading Company. This compared with 25¼ tons in April and 691¼ tons in May last year.

Of the March total, Europe took 1½ tons, Pacific 2, India 11½, Australasia ½ ton, and the Middle East ½ ton. Shipments from Penang totalled 3,998½, compared with 2,535¼ in April and 3,390½ tons in May, 1958. Of the total, the United States took 2,355 tons, Europe 220, Canada 80, Japan 726½, Pacific 38½, India 313, South America 100¼, Africa 5, Australasia 137, and the Middle East 23 tons.

Goods for Trade Fairs

A law has been passed by the United States Congress, to be known as the "Trade Fair Act of 1959," which provides permanent legislation permitting the free entry under bond of goods imported for exhibition or for use in constructing, installing or maintaining foreign exhibits at trade fairs in the United States.

Prior to the passage of this Act, separate laws had to be enacted for each trade fair in order to provide the necessary free entry under bond. Under the new law, when the Secretary of Commerce is satisfied that the public interest in promoting trade will be served by allowing a fair to benefit from the privileges provided by the Act, he will advise the Secretary of the Treasury, designating the name of the fair, the place where it will be held, its duration, and the name of the operator.

The law also permits goods to be sold and removed from the fair whilst it is in progress upon payment of any applicable duties and internal revenue taxes. Provision is also made for goods to be transferred from a fair to other Customs duty status, to a foreign trade zone, or exported without payment of any duties or internal revenue tax.

The law contains a section dealing with marking, packaging and labelling. Items for exhibition or for use in constructing or installing exhibits are not required to be marked in accordance with the United States Custom marking laws. Goods for exhibition shall not be subject to the packaging, marking or labelling requirements of the Internal Revenue Code or of the Federal Alcoholic Administration Act, but must be conspicuously marked prior to exhibition "Not labelled or packaged as required by law—not for sale." Any such items removed for consumption within the United States must comply with the necessary packaging, marking and labelling requirements.

Cooling Tower Maintenance

A portable cooling tower gantry to assist with tower maintenance has recently been developed by **Head Wrightson Processes Limited.** The removal of the induced draught fan and fan drive gear box for inspection and maintenance necessitates rigging up suitable tackle, which normally delays in bringing the tower back into service, and to speed this operation the Head Wrightson Com-Pact gantry has been designed.

An essential feature is the ability to manhandle the various components to the fan deck of the tower for assembly, and this has been done by making the main beam in short sections. Each beam is of deep, braced dual box construction, which can be built up into a rigid beam of suitable span to clear the fan stack, with joints having a wide bearing face to eliminate any deflection under load. The tripod legs are of tubular construction, suitably braced and provided with a central rib-brace to ensure stability. The beam is coupled to the top of each leg with a wide bearing connection similar to the beam section joints.

Each tripod leg is fitted with two swivelling self-aligning castors, allowing the gantry to run the full length of the deck and also to rotate around the fan stack, which allows the equipment to be stowed in any suitable position on the deck. The trolley, running on the top of the beam, is fitted with four rollers and also with a suitable hanging bar for the lifting blocks. The gantry is designed for a safe working load of 20 cwt., with a span of 24 ft.

When not in service on the cooling tower, this equipment can be used for many lifting purposes and, being portable, may be moved to various locations with the span reduced by omitting one or more sections as necessary for operation in confined positions.

Dust Extraction

An interesting brochure has just been published by **Keith Blackman Ltd.** drawing attention to their range of fabric dust collectors known as the series TF. Designed to collect fine, dry dusts in, for example, the foundry, chemical engineering and general engineering industries, the series is available in sizes for handling from 2,000 to 50,000 ft³ of dust-laden air per minute.

The outstanding advantage of this range is that the form of unit construction employs a basic element of 16 filter bags, giving a total filtering area of 200 ft². The complete range is obtained (with the exception of the smallest unit) by stacking two or more basic elements together. This unit construction provides flexibility and compactness. Dust trapped by the filter bags is deposited in one of three different types of receptacles—sack, bin or box. The shaking gear is of either the hand-wheel or mechanical type.

U.S. Scrap Metals

Secondary zinc recovered in zinc-base products in the United States rose 4 per cent to 12,200 short tons in March, according to the Bureau of Mines, United States Department of the Interior. Total stocks of zinc scrap were virtually unchanged at 38,100 tons on March 31. Consumption of zinc scrap at 17,300 tons was the highest monthly rate of use since June, 1957. The use of rod and die scrap, sal skimmings, skimmings and ashes, and chemical residues, increased substantially. Declines in the use of die-cast skimmings, die-castings, old zinc and new clippings were insufficient to balance increases in the use of all other zinc scrap. Output of redistilled slab dropped slightly, but production of the zinc pigments from secondary materials increased. Output of zinc oxide, zinc chloride and zinc dust from scrap gained 9, 43 and 8 per cent respectively.

Domestic consumption of purchased aluminium-base scrap in January, 1959, totalled 36,295 short tons, a drop of 5 per cent compared with December's total of 38,272 tons, according to the Bureau. Production of aluminium alloys at secondary smelters in January declined 24 per cent to 18,987 tons, and shipments from smelters decreased 20 per cent to 19,407 tons. The use of new scrap dropped 1,300 tons, and old scrap consumption declined 700 tons. Receipts of scrap in January were 5,000 tons less than in the previous month, and stocks dropped to 24,000 tons, a decline of 3,000 tons.

Metal Market News

LAST week's Metal Exchange trading was entirely uneventful and lacking in any special interest, with turnovers in all four metals below the average. Criticism of the London market as a medium for the establishment of values certainly could not be valid on the score of undue price variation so far as last week was concerned, for on balance there was virtually no change from one Friday to the next. May lead declined by 17s. 6d. but that was the only significant alteration. Copper began the week with a burst of strength, for on Monday's midday market the cash quotation was £244 5s. 0d., which was more than £3 above the previous Friday's figure. Stocks were reported up by a further 250 tons to 11,516 tons, but this did not help the backwardation, which actually widened to £2 5s. 0d. However, in the afternoon the price fell back, and on Tuesday there was something like a collapse to £238 15s. 0d. for cash and £237 5s. 0d. for three months. This followed news of adverse fabricator statistics in the United States for April, since it appeared that the mills were not absorbing as much as had been expected. On the New York futures market values dropped sharply and this, of course, affected London. Indeed, it is fair to say that last week saw Whittington Avenue very much under the influence of Comex where, however, the possibility of a strike in July continues to be the chief factor making for bullish sentiment. The turnover on Comex last week was heavy, but one or two days suggested diminishing business, and one cannot help wondering whether, perhaps, the prolonged and remarkable period of speculation in copper futures is coming to an end.

It is, of course, by no means impossible that if no strike takes place, and satisfactory wage negotiations lead to the establishment of an agreed wage basis for three years, participation by outside interests in copper futures in New York will evaporate. For the next month, however, hopes and fears will alternate, and the price graph of copper is likely to reflect a jumpy trend. It has already been stated that on balance the copper quotation showed little change last week, and actually on balance cash closed 10s. better at £241 10s. 0d. and three months 15s. up at £240 10s. 0d. The turnover was about normal, excluding Kerb business, which was probably not up to average. The sharp rise in the quotation for standard copper at the beginning of the week seems to have been due to fears that stocks here would be drawn upon for shipment to the United States, and it was suggested also that buying by Iron Curtain countries was in evidence. By and large, however, business with consumers was not good, and Continental reports tell a similar story of conditions outside this country.

Trading conditions in tin were decidedly quiet, and on one or two days the market was idle. Stocks fell by 112 tons to 8,115 tons, and it seems as though the Pool were continuing to sell. On balance there was no change in the quotation at £785 10s. 0d. for cash and three months. Minor fluctuations occurred from day to day. In lead the contango increased from 10s. to £1 15s. 0d., the close being £69 17s. 6d. for the current month and £71 12s. 6d. for August. Trade demand is reported as being only moderately good. In zinc, the backwardation narrowed from £2 to 25s. At the close of business, May was quoted £78 10s. 0d. and August £77 5s. 0d., these prices showing a drop of 5s. and a gain of 10s. for the respective positions. The Tin Council has decided to raise export quotas for the third quarter by 2,000 tons to 25,000 tons.

Birmingham

Steady recovery is evident amongst the metal-using trades of the Midland area and there is a confident feeling that greater expansion will be seen in the autumn. The Midland Region's unemployment rate has fallen from 2·1 to 1·5 in a month, and there are now many more vacancies than there were at the beginning of the year. According to one manufacturer, orders for commercial vehicles have increased by 50 per cent since the concession in tax was made in the Budget. There is a big demand for metal components for the motor trade and many small firms are maintaining steady production of these lines. Electrical engineers are busy, including work for the railway electrification schemes.

The offer of cheaper steel for buying in larger quantities is expected to bring out some of the business that it is believed has been held up in the hope of lower prices all round. The outlook in the trade is more confident than it has been for a long time. There is plenty of room for improvement in orders for structural steel, but plate mills are steadily employed, and some of the sheet makers are being pressed to increase deliveries to the motor trade. The area leads the country in the production of iron castings. More orders have been acquired by the re-rolling mills.

New York

Copper futures were steady and quiet last week. Physical copper was quiet reflecting the pre-holiday atmosphere and the skeleton staff at most leading companies. Producers and smelters reported quiet demand because of the Memorial Day weekend. Tin was quite firm in spot and prompt position. A squeeze developed up to the first half of June shipment but there was little interest beyond that position. Trade sources commented that the International Tin Council action was quite skilful, adding a modest amount of supply to the market, but in view of a possible steel strike here, it was not markedly adding to supply. Some sources said that a steel strike might bring lower tin prices immediately in its wake, but the market could easily firm up again by the end of July. Lead and zinc were quiet. In later trading, tin was firm, both spot and prompt, but delivery and prices were only nominal since no offerings were available. Copper, lead and zinc were unchanged.

Paris

The French Government has its gaze fixed on Guinea. No move is being taken in Paris to bring the black sheep back to the fold, but behind the scenes feverish activity is going on. The newly-formed Federation of Mali, which is a member of the French Community, has, indeed, been charged to act as go-between, and it is hoped in Paris that Guinea will be brought back to the fold. The reason for this is primarily economic. The French have in mind the new Fria aluminium plant, now under construction some 95 miles from Conakry. This was visited recently by Mr. Shockley, of the American Olin Mathieson Company, and Mr. J. Boex, of British Aluminium. Recently, the Dutch cargo ship *Senegal Kust* shipped two huge evaporators for the Fria plant. They were built by the Constructions Métaliques de Provence.

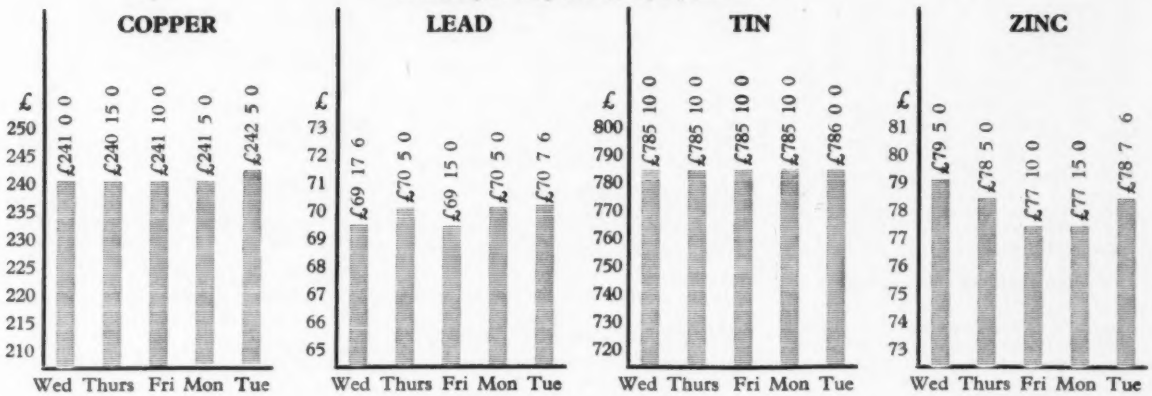
It is generally believed in Paris that Guinea will not be able to continue as an independent State for very long, and that sooner or later the country will either drop into the lap of the British Commonwealth or tip back into the French community. The economic future of Guinea looks bright, particularly in the non-ferrous metal field.

The Alucam Company, of Edea, Cameroons, in a report, states that in 1958, 31,861 tons of aluminium were produced at a value of something under £2,000,000. In 1957, the company produced only 7,530 tons, and in 1959 it is expected to produce over 45,000 tons. The whole production was exported, France taking 19,485 tons. France also exported to the Cameroons some 72,300 tons of aluminium for the Alucam plant.

Non-Ferrous Metal Prices

London Metal Exchange

Wednesday 27 May to Tuesday 2 June 1959



Primary Metals

All prices quoted are those available at 2 p.m. 2/6/59

		£	s.	d.
Aluminium Ingots....	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%..	„	190	0	0
Antimony Oxide.....	„	180	0	0
Antimony Sulphide Lump.....	„	190	0	0
Antimony Sulphide Black Powder.....	„	205	0	0
Arsenic.....	„	400	0	0
Bismuth 99·95%.....	lb.		16	0
Cadmium 99·9%	„		9	0
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		14	0
Columbite.... per unit			—	
Copper H.C. Electro..	ton	242	5	0
Fire Refined 99·70%	„	241	0	0
Fire Refined 99·50%	„	240	0	0

		£	s.	d.
Copper Sulphate	ton	76	0	0
Germanium	grm.		—	
Gold	oz.	12	9	7½
Indium	„		10	0
Iridium.....	„	24	0	0
Lanthanum	grm.		15	0
Lead English.....	ton	70	7	6
Magnesium Ingots....	lb.		2	3
Notched Bar	„		2	9½
Powder Grade 4.....	„		6	1
Alloy Ingot, A8 or AZ91	„		2	4
Manganese Metal....	ton	245	0	0
Mercury	flask	77	10	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium]	„		nom.	

		£	s.	d.
Palladium	oz.	7	5	0
Platinum	„	28	10	0
Rhodium	„	41	0	0
Ruthenium	„	18	0	0
Selenium	lb.		nom.	
Silicon 98%.....	ton		nom.	
Silver Spot Bars.....	oz.		6	7½
Tellurium	lb.		15	0
Tin.....	ton	786	0	0
***Zinc**				
Electrolytic.....	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	77	15	0
Dust 95/97%.....	„	109	0	0
Dust 98/99%.....	„	115	0	0
Granulated 99+% ..	„	102	15	0
Granulated 99·99+%	„	116	6	3

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏£/ton	Canada c/lb ≏£/ton	France fr/kg ≏£/ton	Italy lire/kg ≏£/ton	Switzerland fr/kg ≏£/ton	United States c/lb ≏£/ton
Aluminium		22.50 185 17 6	224 165 0	375 221 5	2.50 212 10	26.80 214 10
Antimony 99.0			220 163 0	445 262 10		29.00 232 0
Cadmium			1,350 1,012 10			130.00 1,040 0
Copper						
Crude				460 271 10 0		
Wire bars 99.9 Electrolytic	33.25 244 15 0	30.50 252 0	334 250 10		3.00 255 0	31.50 252 0
Lead		10.25 84 12 6	103 78 0	168 99 2 6	.88 74 17 6	12.00 96 0
Magnesium						
Nickel		70.00 578 5	900 675 0	1,200 708 0	7.50 637 10	74.00 592 0
Tin	111.25 817 2 6		1,125 843 15	1,500 885 0	9.70 824 12 6	104.00 832 0
Zinc						
Prime western		11.25 92 17 6				11.00 88 0
High grade 99.95		11.85 94 0 0				
High grade 99.99		12.25 101 2 6				
Thermic			117.00 87 17 6			
Electrolytic			125.00 93 17 6	177 104 10	1.02 86 17	12.25 98 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 2/6/59

	£	s.	d.
Aluminium Alloy (Virgin)			
B.S. 1490 L.M.5 .... ton	210	0	0
B.S. 1490 L.M.6 .... „	202	0	0
B.S. 1490 L.M.7 .... „	216	0	0
B.S. 1490 L.M.8 .... „	203	0	0
B.S. 1490 L.M.9 .... „	203	0	0
B.S. 1490 L.M.10.... „	221	0	0
B.S. 1490 L.M.11.... „	215	0	0
B.S. 1490 L.M.12.... „	223	0	0
B.S. 1490 L.M.13.... „	216	0	0
B.S. 1490 L.M.14.... „	224	0	0
B.S. 1490 L.M.15.... „	210	0	0
B.S. 1490 L.M.16.... „	206	0	0
B.S. 1490 L.M.18.... „	203	0	0
B.S. 1490 L.M.22.... „	210	0	0
†Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 .... ton	153	0	0
B.S. 1490 L.M.2 .... „	163	0	0
B.S. 1490 L.M.4 .... „	178	0	0
B.S. 1490 L.M.6 .... „	189	0	0
***Aluminium Bronze**			
BSS 1400 AB.1..... ton	234	0	0
BSS 1400 AB.2..... „	248	0	0
***Brass**			
BSS 1400-B3 65/35 .. ton	158	0	0
BSS 249..... „		—	
BSS 1400-B6 85/15 .. „	215	0	0
***Gunmetal**			
R.C.H. 3/4% ton .... „		—	
(85/5/5/5) LG2 ..... „	196	0	0
(86/7/5/2) LG3 ..... „	206	0	0
(88/10/2/1)..... „	247	0	0
(88/10/2/½)..... „	260	0	0
***Manganese Bronze**			
BSS 1400 HTB1.... „	190	0	0
BSS 1400 HTB2.... „	208	0	0
BSS 1400 HTB3.... „	220	0	0
Nickel Silver			
Casting Quality 12% „	225	0	0
„ „ 16% „	235	0	0
„ „ 18% „	245	0	0
***Phosphor Bronze**			
B.S.1400 P.B.1.(A.I.D. released)..... „	290	0	0
B.S. 1400 L.P.B.1.... „	218	0	0
**Phosphor Copper*			
10% ..... ton	256	0	0
15% ..... „	258	10	0
Phosphor Tin			
5% ..... „		—	
Silicon Bronze			
BSS 1400-SB1 ..... „	250	0	0
Solder, soft, BSS 219			
Grade C Tinmans.... „	365	0	0
Grade D Plumbers.. „	294	0	0
Grade M ..... „	401	0	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 „ „		—	
Zinc Alloys			
Mazak III ..... ton	109	11	3
Mazak V ..... „	113	11	3
Kayem ..... „	119	11	3
Kayem II ..... „	125	11	3
Sodium-Zinc ..... lb.		2	6½

*Average prices for the last week-end.

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium			
Sheet 10 S.W.G. lb.		2	8½
Sheet 18 S.W.G. „		2	10½
Sheet 24 S.W.G. „		3	1½
Strip 10 S.W.G. „		2	8½
Strip 18 S.W.G. „		2	9½
Strip 24 S.W.G. „		2	11
Circles 22 S.W.G. „		3	2½
Circles 18 S.W.G. „		3	1½
Circles 12 S.W.G. „		3	0½
Plate as rolled ..... „		2	8
Sections ..... „		3	2
Wire 10 S.W.G. .... „		2	11½
Tubes 1 in. o.d. 16 S.W.G. ..... „		4	1
Aluminium Alloys			
BS1470. HS10W.			
Sheet 10 S.W.G. „		3	1
Sheet 18 S.W.G. „		3	3½
Sheet 24 S.W.G. „		3	11
Strip 10 S.W.G. „		3	1
Strip 18 S.W.G. „		3	2½
Strip 24 S.W.G. „		3	10½
BS1477. HP30M.			
Plate as rolled..... „		2	11
BS1470. HC15WP.			
Sheet 10 S.W.G. „		3	9½
Sheet 18 S.W.G. „		4	2
Sheet 24 S.W.G. „		5	0½
Strip 10 S.W.G. „		3	10½
Strip 18 S.W.G. „		4	2
Strip 24 S.W.G. „		4	9½
BS1477. HPC15WP.			
Plate heat treated.. „		3	6½
BS1475. HG10W.			
Wire 10 S.W.G. „		3	10½
BS1471. HT10WP.			
Tubes 1 in. o.d. 16 S.W.G. ..... „		5	0½
BS1476. HE10WP.			
Sections ..... „		3	1½
Brass			
Tubes..... „		1	10⅞
Brazed Tubes..... „		—	
Drawn Strip Sections „		—	
Sheet ..... ton		—	
Strip ..... „	258	10	0
Extruded Bar..... lb.		2	0¾
Extruded Bar (Pure Metal Basis) ..... „		—	
Brass			
Condenser Plate (Yellow Metal)..... ton	194	0	0
Condenser Plate (Naval Brass) ..... „	206	0	0
Wire ..... lb.		2	8½
Beryllium Copper			
Strip ..... „	1	4	11
Rod..... „	1	1	6
Wire ..... „	1	4	9
Copper			
Tubes ..... lb.		2	4
Sheet ..... ton	268	15	0
Strip ..... „	268	15	0
Plain Plates ..... „		—	
Locomotive Rods .... „		—	
H.C. Wire ..... „	292	5	0
Cupro Nickel			
Tubes 70/30 ..... lb.		3	7⅞
Lead			
Pipes (London) .... ton	111	5	0
Sheet (London) .... „	109	0	0
Tellurium Lead .... „	£6 extra		
Nickel Silver			
Sheet and Strip 7% .. lb.		3	8
Wire 10% ..... „		4	2¾
Phosphor Bronze			
Wire ..... „		4	1⅛
Titanium (1,000 lb. lots)			
Billet 4½″ to 18″ dia... lb.	54/-	55/-	
Rod ½″ to 4″ dia. .... „	95/-	62/-	
Wire ·036″ – ·232″ dia. „	167/-	110/-	
Strip ·003″ to ·048″ .. „	200/-	75/-	
Sheet 8′×2′. 20 gauge „	85/-		
Tube, representative average gauge..... „	300/-		
Extrusions ..... „	105/-		
Zinc			
Sheet ..... ton	113	5	0
Strip ..... „	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 2/6/59.

	£
Aluminium	
New Cuttings	146
Old Rolled	126
Segregated Turnings	98
Brass	
Cuttings	162
Rod Ends	152
Heavy Yellow	126
Light	122
Rolled	154
Collected Scrap	124
Turnings	141
Copper	
Wire	218
Firebox, cut up	212
Heavy	208
Light	203
Cuttings	218
Turnings	200
Braziery	165
Gunmetal	
Gear Wheels	185
Admiralty.....	185
Commercial.....	167
Turnings	162
Lead	
Scrap	60
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	167
Turnings	162
Zinc	
Remelted	68
Cuttings	53
Old Zinc	38

Financial News

Coley Metals

Group net profit year to January 31, 1959, £34,158 (£39,186), and dividend 15 per cent (20 per cent). Current assets £664,360 (£559,184) and liabilities £473,545 (£345,810), including overdraft £130,852 (£37,554).

Amalgamated Metal Corpn.

Group net profit, 1958, £405,160 (£432,903) and dividend 9 per cent (same). Current assets £15,532,052 (£12,912,361), including cash and loans £1,181,970 (£1,063,624), tax certificates £469,875 (£301,150) and British Funds £935,484 (£934,926) with market value £801,266 (£752,282). Current liabilities £9,620,450 (£7,672,015), including bank overdrafts £2,237,525 (£2,086,935) and loan from associated company £120,000 (£137,000).

H. J. Enthoven and Sons

Consolidated loss, 1958, £66,927 (£156,334). Unrequired tax, etc., £15,662 (£2,200). From general reserve £52,000 (£40,000). Forward £332 (£37). No Ordinary dividend (same).

Glacier Metal Co.

Net profit advanced from £102,421 to £117,164 in the year to February 28, 1959, after tax of £95,300 (£126,597). The 1957-58 profit included £15,000 from stock reserve. Dividend is maintained at 11½ per cent, absorbing £52,828 (£49,594). General reserve receives £35,000 (£30,000).

Wrought Titanium Prices

The largest reductions so far made in the price of British wrought titanium products are announced by the Metals Division of Imperial Chemical Industries Ltd The heaviest cuts are in prices for sheet, strip, plate and wire, which are reduced by 25 per cent. Rod and billet prices are cut by 15 per cent, and extrusions (latest addition to the range of I.C.I. wrought titanium products) by 12½ per cent.

These reductions—the second in twelve months — bring the price of I.C.I. wrought titanium to less than half the level operating in 1955, when the company started commercial production.

Armstrong Whitworth (Metal Industries)

Group net profit, 1958, £205,618 (£219,206), and dividend 10 per cent (same) on capital increased by two-for-five scrip issue. Fixed assets £669,233 (£570,720). Current assets £1,694,361 (£1,715,995), and liabilities £521,789 (£510,083). Investments £40,060 (nil). Commitments £153,000 (£214,000).

Turkish Chrome

A new chrome ore export price of 33·50 dollars per ton has been fixed by the Turkish Chrome Committee in Istambul. In the past the price has never been lower than 40 dollars.

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Techniplant Developments Limited (627670), "Swarthmore," Castle Close, Stotfold, Beds. Registered May 7, 1959. To carry on business of manufacturers of and dealers in mechanical, electrical and metallurgical processes or products, etc. Nominal capital, £2,500 in 10s. shares (3,000 Ord., 1,800 Cum. First Pref., and 200 Non-Cum. Second Pref.). Directors: Arthur K. Jeffrey, Marjorie M. Jeffrey and Charles C. D. Cain.

Supachrome Electro-Deposits Limited (627912), 34 Copthall Ave., E.C.2. Registered May 11, 1959. Nominal capital, £100 in £1 shares. Directors: Leonard R. Howard and Miss Louisa Collins.

Crichton Metals Limited (627939), 63 Park Place, Cardiff. Registered May 12, 1959. Nominal capital, £500 in £1 shares. Directors: Richard Steel and Thomas E. Jenkins.

P. Quigley (Metal Products) Limited (628231), Temple Street, Wolverhampton. Registered May 14, 1959. Nominal capital, £2,000 in £1 shares. Directors: Peter Quigley and Mrs. Ellen Quigley.

Trade Publications

Titanium for Chemical Plant.—Imperial Chemical Industries Ltd., Metals Division, P.O. Box 216, Birmingham, 6.

This is a new leaflet in the series dealing with the use of titanium in chemical plant. It deals with titanium for compressor valve plates and springs, and the data are accompanied by a number of illustrations.

Electric Die-Casting Furnace. — The Morgan Crucible Company Ltd., Battersea Church Road, London, S.W.11.

A four-page brochure in colour provides details of the Birlec-Morgan electric die-casting furnace, which is described as an electrically-heated crucible furnace combining the metallurgical advantages and the flexibility of crucible melting with the precise temperature control, automatic operation, cleanliness and ideal working conditions of electric heating.

Guillotine Shears. — The Cincinnati Shaper Co. Ltd., Peel Park Place, East Kilbride, Glasgow, Scotland.

This 12-page catalogue in three colours covers the company's range of British-built American designed shears. These shears are of all-steel interlocked construction and incorporate, among other features, powerful hydraulic hold-downs, non-float inclined ram, front controlled power operated back gauge, rugged multiple jaw clutch, and automatic pressure lubrication.

Electric Furnaces. — Royce Electric Furnaces Ltd., Sir Richard's Bridge, Walton-on-Thames, Surrey.

In this coloured brochure of eight pages, the electric box type furnaces manufactured by this company are described and illustrated. The two standard ranges are fully detailed, including dimensions and specifications.

Electronic Instruments. — The Solartron Electronic Group Ltd., Thames Ditton, Surrey.

The annual review of this group for the year 1958 is contained in an elaborately produced brochure of some 28 pages, and is devoted to some details of some of the achievements of the group during the past year. Illustrations are given of some of the new buildings, and also of many of the various departments at work.

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

West Germany (D-marks per 100 kilos):		
Used copper wire ..	(£210.5.0)	240
Heavy copper	(£210.5.0)	240
Light copper	(£183.17.6)	210
Heavy brass	(£122.15.0)	140
Light brass	(£92.0.0)	105
Soft lead scrap	(£57.0.0)	65
Zinc scrap	(£36.15.0)	42
Used aluminium unsorted	(£83.5.0)	95
France (francs per kilo):		
Electrolytic copper scrap	(£191.5.0)	255
Heavy copper	(£191.5.0)	255
No. 1 copper wire ..	(£180.0.0)	240
Light brass	(£112.12.6)	150
Zinc castings	(£48.15.0)	65
Lead	(£64.12.6)	86
Aluminium	(£120.0.0)	160

Italy (lire per kilo):		
Aluminium soft sheet clippings (new) ..	(£197.12.6)	335
Aluminium copper alloy	(£126.17.6)	215
Lead, soft, first quality	(£75.12.6)	128
Lead, battery plates	(£41.17.6)	71
Copper, first grade	(£215.10.0)	365
Copper, second grade	(£203.2.6)	345
Bronze, first quality machinery	(£200.15.0)	340
Bronze, commercial gunmetal	(£171.2.6)	290
Brass, heavy.....	(£138.15.0)	235
Brass, light	(£123.17.6)	210
Brass, bar turnings ..	(£127.0.0)	215
New zinc sheet clippings	(£60.2.6)	102
Old zinc	(£45.10.0)	77

LIGHT METALS STATISTICS IN JAPAN

(January, 1959)

Classification	Production	Shipment	Stock	Export
Alumina	26,709	21,089	17,386	6,824
Aluminium				
Primary	7,858	7,766	3,702	50
Secondary	2,088	2,086	309	0
Rolled Products	6,259	6,279	1,859	651
Electric Wire	646	1,125	473	32
Sheet Products	1,465	1,478	1,096	73
Castings	1,650	—	—	—
Die-Castings	970	—	—	—
Forgings	27	—	—	—
Powder	—	—	—	—
Primary Aluminium (February)	6,748	7,501	2,949	0
Sponge Titanium	166	—	—	178
Magnesium	112	101	53	0
Secondary	218	21	320	0

THE STOCK EXCHANGE

Active Support For Industrials. Alfred Case Jumped To 7/3 On Offer From Delta Metal

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 1 JUNE	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1959 HIGH	1959 LOW	1958 HIGH	1958 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	27/1½	—1½d.	9	9	6 12 9	27/3	23/3	24/9	17/6
400,000	2/–	Anti-Attrition Metal	1/3		4	8½	6 8 0	1/6	1/3	1/9	1/3
41,303 829	Stk. (£1)	Associated Electrical Industries ...	62/–	+3d.	15	15	4 16 9	62/–	54/–	58/9	46/6
1,613,280	1	Birfield	48/9	—2/6	15	15	6 3 0	59/-	47/–	62/4½	46/3
3,196,667	1	Birmid Industries	81/9	+1/9	17½	17½	4 5 6	81/9	72/–	77/6	55/3
5,630,344	Stk. (£1)	Birmingham Small Arms	43/9		11	10	5 0 6	44/1½	36/1½	39/–	23/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/6		5	5	6 9 0	16/3	15/–	16/1½	14/7½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/9		6	6	6 15 3	18/1½	17/9	17/4½	16/6
500,000	1	Bolton (Thos.) & Sons	32/6	+1/3	10	10	6 3 0	32/6	27/6	28/9	24/–
300,000	1	Ditto Pref. 5%	15/6		5	5	6 9 0	15/6	15/–	16/–	15/–
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/6	+6d.	7	7	6 16 6	20/6	20/–	20/4½	19/-
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	19/6		6	6	6 3 0	19/7½	18/9	20/-	18/4½
17,247,987	Stk. (£1)	British Insulated Callender's Cables	55/6	—3d.	12½	12½	4 10 0	56/–	47/6	52/6	38/9
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	63/3	+1/–	10	10	3 3 3	64/–	49/3	52/-	28/3
1,200,000	Stk. (5/–)	Canning (W.) & Co.	15/6xcap		25 + *2½C‡	25	4 0 9	32/–	15/6	25/3	19/3
60,484	1/–	Carr (Chas.)	2/7½		12½	25	4 15 3	2/7½	1/3	2/3	1/4½
150,000	2/–	Case (Alfred) & Co. Ltd.	7/3	+1/9	25	25	6 18 0	7/3	4/7½	5/3	4/–
555,000	1	Clifford (Chas.) Ltd.	23/9	+3d.	10	10	8 8 6	23/9	22/6	22/-	16/–
45,000	1	Ditto Cum. Pref. 6%	16/–		6	6	7 10 0	16/–	15/3	16/–	15/–
250,000	2/–	Coley Metals	3/6		15	20	8 11 6	4/–	2/10½	4/6	2/6
10,185,696	1	Cons. Zinc Corp.†	68/6	+3/–	15	18½	4 7 6	68/6	60/–	65/3	41/–
1,509,528	1	Davy & United	108/9	+5/–	20	15	3 13 6	113/9	86/–	87/–	45/9
5,830,000	5/-	Delta Metal	17/1½	+1½d.	31‡	30	4 10 6	33/7½	16/3	25/–	17/7½
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	55/1½	—2/4½	15	12½	5 8 9	57/6	36/7½	38/–	22/9
750,000	1	Evered & Co.	30/3	—1/9	10§	15 Z	6 12 3	32/–	30/–	30/–	26/
18,000,000	Stk. (£1)	General Electric Co.	34/9	+9d.	10P	12½		40/3	30/6	40/6	29/6
1,500,000	Stk. (10/–)	General Refractories Ltd.	35/3	+1/–	20	20	5 13 6	40/–	32/6	39/3	27/3
401,240	1	Gibbons (Dudley) Ltd.	65/–	+1/–	16½	15	5 1 6	66/6	63/6	67/6	61/–
750,000	5/–	Glacier Metal Co. Ltd.	7/6	+3d.	11½	11½	7 13 3	7/6	6/7½	8/3	5/–
1,750,000	5/–	Glynwed Tubes	20/6	+1/9	20	20	4 17 6	20/6	16/4½	18/1½	12/10½
5,421,049	10/–	Goodlass Wall & Lead Industries ...	38/9	+3d.	13‖	18Z	3 7 3	38/9	28/7½	30/9	17/3
342,195	1	Greenwood & Batley	84/–		20	17½	4 15 3	84/–	75/–	57/9	45/-
396,000	5/–	Harrison (B'ham) Ord.	18/10½	+1½d.	*17½	*15	4 12 9	19/–	14/11½	15/9	11/6
150,000	1	Ditto Cum. Pref. 7%	19/6		7	7	7 3 6	—	—	19/9	18/4½
1,075,167	5/–	Heenan Group	8/3		10	10‡	6 1 3	8/6	7/6	9/7½	6/9
236,958,260	Stk. (£1)	Imperial Chemical Industries ...	37/3	+2/6	12Z	10	4 6 0	38/3	33/9	38/–	24/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	16/6		5	5	6 1 3	17/1½	16/–	17/1½	16/–
14,584,025	••	International Nickel	166	+2½	$2.60	$3.75	2 15 9	171	153	169	132‡
860,000	5/–	Jenks (E. P.), Ltd.	11/1½	+6d.	14	27½φ	6 5 9	11/1½	8/9	10/–	6/7½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3		5	5	6 3 0	16/3	15/4½	16/9	15/–
3,987,435	1	Ditto Ord	60/–	+2/–	10	10	3 6 9	60/–	44/3	47/–	36/6
600,000	10/–	Keith, Blackman	30/–		17½E	15	5 16 9	30/–	25/–	28/9	15/–
320,000	4/–	London Aluminium	5/9		10	10	6 19 3	6/4½	5/3	6/–	3/–
765,012	1	McKechnie Brothers Ord.	40/9		15	15	7 7 3	45/–	42/6	45/–	32/–
1,530,024	1	Ditto A Ord.	38/9		15	15	7 14 9	43/6	38/9	45/–	30/–
1,108,268	5/–	Manganese Bronze & Brass	15/6	—9d.	20‖	20	6 14 3	16/3	13/9	14/1½	8/9
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–		7½	7½	7 10 0	—	—	6/3	5/6
13,098,855	Stk. (£1)	Metal Box	85/–	+4/6	11	11	2 11 9	85/–	66/6	73/3	40/6
415,760	Stk. (2/–)	Metal Traders	10/–	+3d.	50	50	10 0 0	10/–	8/4½	9/–	6/3
160,000	1	Mint (The) Birmingham	25/–		10	10	8 0 0	25/–	22/–	22/9	19/–
80,000	5	Ditto Pref. 6%	73/–		6	6	8 4 6	75/6	69/–	83/6	69/–
3,705,670	Stk. (£1)	Morgan Crucible A	46/6		10	10	4 6 0	46/6	43/6	45/–	34/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6		5½	5½	6 5 9	18/6	17/6	18/-	17/–
2,200,000	Stk. (£1)	Murex	44/6	+6d.	17½	20	7 17 3	50/–	42/–	58/9	46/–
468,000	5/–	Ratcliffs (Great Bridge)	9/6	—3d.	10R	10	3 19 0	11/6	9/6	11/1½	6/10½
234 960	10/–	Sanderson Bros. & Newbould ...	37/–		20	27½D	5 8 0	37/–	27/9	27/3	24/6
1,365,000	Stk. (5/–)	Serck	20/4½	—3d.	15	17½	3 13 9	21/-	18/–	18/7½	11/–
6,698,586	Stk. (£1)	Stone-Platt Industries	53/6	+9d.	15	12½	5 12 3	53/6	43/3	45/6	22/6
2 928.963	Stk. (£1)	Ditto 5½% Cum. Pref.	17/6		5½	5½	6 5 9	17/6	15/10½	16/3	12/7½
18,255.219	Stk. (£1)	Tube Investments Ord	89/3	+2/–	17½	15	3 18 6	89/3	72/–	86/–	48/4½
41,000,000	Stk. (£1)	Vickers	33/6	—1½d.	10	10	5 19 6	37/–	30/6	36/3	28/9
750,000	Stk. (£1)	Ditto Pref. 5%	14/3		5	5	7 0 3	15/0½	14/3	15/9	14/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/3		•5	•5	7 5 0A	22/7½	21/–	23/–	21/3
2,200,000	1	Ward (Thos. W.), Ord.	95/–	+3/3	20	15	4 4 3	95/–	83/6	87/3	70/9
2,666,034	Stk. (£1)	Westinghouse Brake	43/6		10	10	4 12 0	47/–	39/9	46/6	32/6
225,000	2/–	Wolverhampton Die-Casting ...	9/4½	—3d.	30	25	6 8 0	10/6	8/8½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	26/6		27½	27½	5 3 9	28/6	21/6	22/9	14/9
78,465	2/6	Wright, Bindley & Gell	6/9	+1½d.	20	20	7 8 3	6/9	4/11½	5/4½	2/9
124,140	1	Ditto Cum. Pref. 6%	13/9		6	6	8 14 6	13/9	13/6	13/-	11/3
150,000	1/–	Zinc Alloy Rust Proof	3/1½	+1½d.	27	40D	8 12 9	3/1½	2/9	3/1½	2/7½

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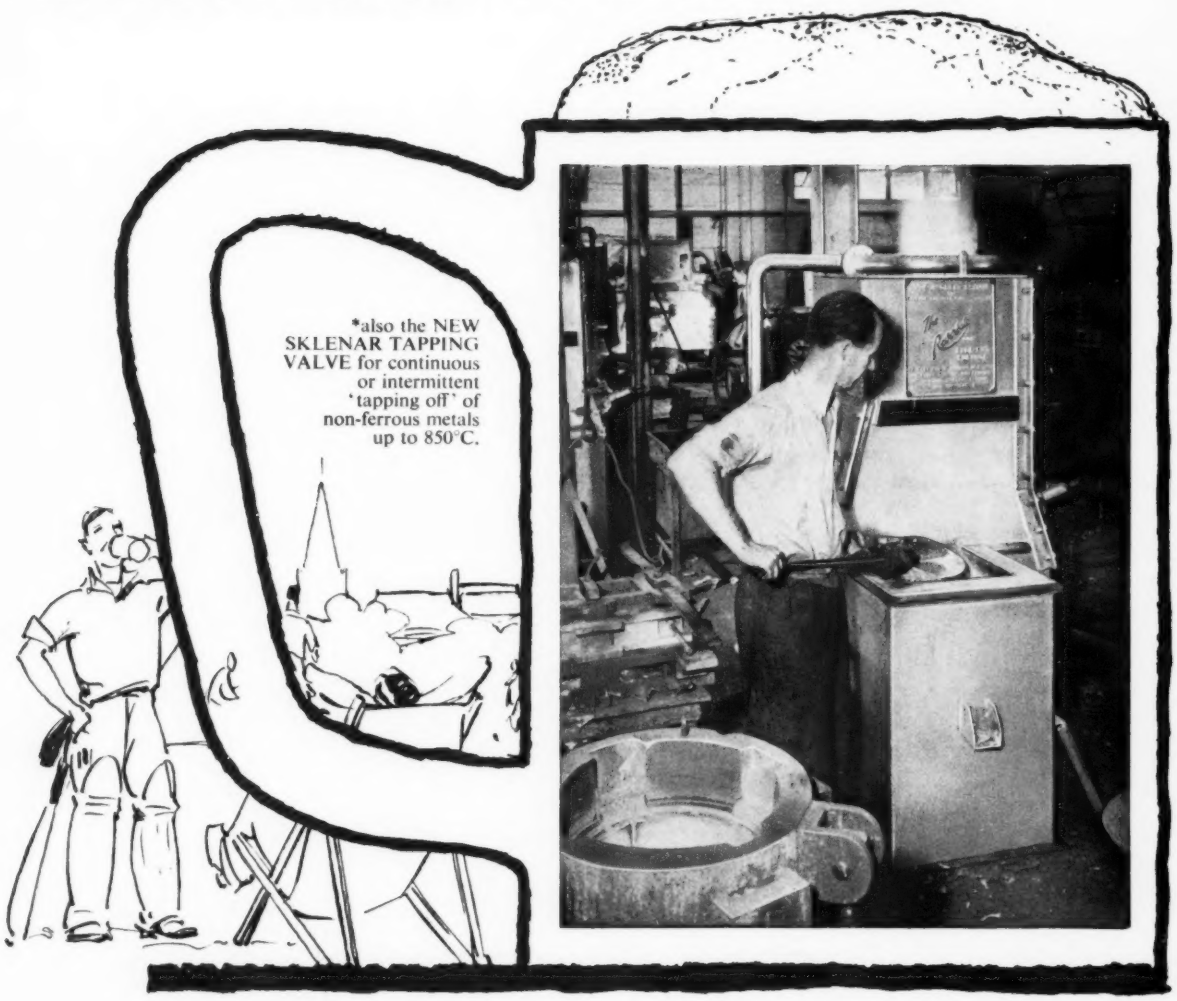

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